AMERICAN RAILROAD JOURNAL

NEW YORK [ETC.]

V. 12, 1841

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AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

VOL. VI.—NEW SERIES,
OR
VOL. XII.

NEW YORK:
PUBLISHED BY THE EDITORS AND PROPRIETORS,
GEORGE C. SCHAEFFER AND EGBERT HEDGE,
No. 120 Nassau Street. (Up Stairs.)
1841.

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No. 1, Vol. VI. New Series. | JANUARY 1, 1841. | Whole No. 373. Vol. XII.

At the commencement of another year of editorial duties we beg leave to offer our best wishes to our readers, together with our hearty thanks for past favors. In accordance with the intention of doing every thing in our power to improve the appearance and character of the Railroad Journal, the reader will perceive that this number appears in a new dress. The type does credit to the establishment of J. T. White, of this city. Although the expense incurred is great in proportion to the size of our establishment, we have not hesitated to make an improvement so conducive to the comfort of the reader and the satisfaction of our contributors. If the encouragement we have received is continued we shall not fail to increase our efforts to merit it by every exertion in our power.

The review of the last volume renders us sensible of the great favors we have received from our friends, by whose kindness we have been enabled to give on an average the half of each number in entirely original matter. The number of communications now on hand leads us to hope that there will be no falling off in this proportion.

The prosecution of internal improvements, of steam navigation and manufacture, being absolutely necessary to our existence as a commercial nation, insures a never failing supply of matters of interest and importance on subjects coming within the province of the Railroad Journal, and it is only necessary that those who are concerned should aid by their contributions to the maintenance of a work, which from its commencement has been identified with their interests.

The development of our national resources deserves a more attentive consideration than it has hitherto received from those engaged in the cause of internal improvement. Our vast mineral wealth and the products of the soil, capable of almost indefinite increase, furnish us with the means of extending our internal and external trade far beyond the present limits even without any increase of population—while the recent census has shown the increase in that respect to be abundantly sufficient to support our railroads, canals, and steamboats—and that a further gain in the same proportion, will require a corresponding extension of the means of conveyance throughout the country.

For the American Rrailroad Journal and Mechanics' Magazine.

ON THE TRUE THEORY OF CRANK MOTION. By *W. Mc Clelland Cushman*, Civil Engineer.

It is, I believe, a settled maxim of science, that that theory must be wrong which disagrees with or does not explain the phenomena of experience. Yet I know of no extant theory of the crank which, when applied to the locomotive engine, does not totally fail to solve the actual loss of effect produced by the operation of the crank in those engines. *See note Vol.* 4, *p.* 243.

For instance, some have contended that more than 1 part in 5 of power, in these engines, is expended without any useful effect, exclusive of friction, etc. *Note* 1.

Others, again, that in general, no part of the power is lost in crank motion, except that caused by extra friction, etc. While, from whatever cause or causes arising, the fact is that rather less than 1 part in 16 of power, or accurately ·0583 of the powers of locomotive engines, is annulled or expressed without effect, through the operation of the crank. So that at all events, *the theory warranted by experience*, has yet to be disclosed.

This unsettled state of the mode of action of a mechanical arrangement of such universal use and importance in machinery, and particularly in the grander movements of the steam engine, after so long a period, it must be admitted affords very decisive proof of its abstruse character; but effects having adequate causes, and the crank being an assemblage of levers of determinate lengths—of use, solely, to change the alternate motion of the power into a rotary motion—the causes of any loss of power actually attending its operation are certainly susceptible of analysis; and the influence or efficacy of each of estimation a priori, etc. I cannot consequently apprehend any difficulty, of an insuperable nature at least, in the way of disclosing and confirming by facts drawn from experience, the general principle of action or theory of the crank: nor of being able to fix upon the amount of power lost through its operation, under every circumstance of practice.

Now in crank motion (as indeed in all machinery) the effect producible by the moving power must always be modified or reduced by one or both of the following causes:

1. *Direct loss of power:* from its not being applicable *directly* to the end of the crank; but from the nature of things, *conveyed to it,* through the agency of a connecting rod, in lines *oblique to the fixed direction in which the power acts;* whereby certain components of the power itself are *compulsorily* expended in directions that cannot contribute to the effect which otherwise would be produced by the same expenditure of power. This fact alone, it will in the sequel be made to appear, originates the greater part of the actual loss of power attending the production of rotary motion by means of a crank.

2. *Indirect loss of power:* from the resistance of friction at rubbing points, opposing the motion in proportion to the pressure upon the surfaces in contact, their nature, etc.

The aggregate influence of each of these general causes is made up of several distinct items of loss taking place at different points. But before entering in the main into the question, it will perhaps be best to give a definite notion of what *really constitutes loss of power.*

For instance, it is true it is a necessary consequence of the laws of motion, that the pressure exerted upon the end of the crank of an engine *must,* at all events, be as much less than the power expended upon its pistons, as the velocity of the crank is greater than the velocity of the pistons; viz. in the ratio of half the circumference of the circle described by the end of the crank to its diameter, which corresponds to the length of stroke of the pistons. But the fact of the *pressure* upon the crank being so much less than the moving power by no means implies any loss of power, because, however much reduced, that pressure is exerted over a space just enough greater than that described by the power to yield, in the same time, the same total of effect as the power actuating the pistons yields. If, therefore, the nature of crank gearing were such as to convey the power of the pistons to the end of the crank (or indeed any other part of the machinery) without any further change than mere reduction of pressure inversely with the velocity of parts, it is clear that the use of the crank could not be attended with any non-effective expenditure of the moving power.

In further illustration of this point, put l for the length of stroke (=double the radius or throw of the crank); P for the power actuating the pistons; p for the pressure upon the end of the crank; and π for the arc of the quadrant to radius 1. Then as from the nature of the connexion of parts, p must describe the space $2\,\pi\,l$ in the same time that P describes the space l, we should have $\frac{1}{l} : \frac{1}{2\pi l} :: P : p$ and consequently $p \cdot 2\,\pi\,l = P\,l$ which shows that the total effect produced by the pressure upon the crank, would in the case supposed, be perfectly identical with the total produced by the power expended upon the pistons.

An actual loss of power or effect can, then, have no reference to *mere reduction of pressure upon the crank*, in the ratio of its excess of velocity over that of the piston; but to some *further change* due the nature of the gearing, causing portions of the force to be expended non-effectively, in transitu, etc. leaving but a residuum of power actually operative upon the crank, less of course, in amount than that which has been represented by p.

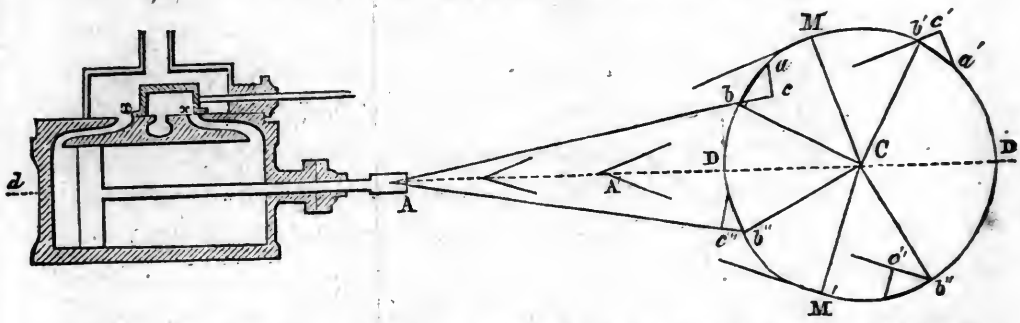
So, in this case, (putting p' for the mean pressure actually effective upon the crank,) since the pressure upon it would be p in case no loss took place, we should evidently have $\frac{p'}{p}$ for the proportion of effect produced to power expended; and consequently

$$\frac{p'}{p} = \frac{p' \cdot 2\pi\,l}{p \cdot 2\,\pi\,l} = \frac{p' \cdot 2\pi\,l}{l \cdot P}.$$

and hence, if we compare, indifferently, either the actual pressure upon the crank with the pressure which would have been exerted upon it, did no loss exist; or, the moment of the actual pressure upon the crank with the moment of the power expended; we shall in either case obtain the true proportion of effect produced to power expended. Profiting accordingly by the liberty of choice in this respect to consult simplicity, I will, in the first instance, consider—

What amount of moment is regularly communicable from the pistons of an engine to the end of its crank, in the direction of its motion; and, afterwards, designate the proportion of power lost, by contrasting that result with the moment of the power expended, agreeably to the foregoing principles.

Let then A b, A′ b', etc. represent positions of the connecting rod corresponding with b C, b' C, etc. positions of the crank; d D D′ the fixed direction in which the force P, upon the pistons, alternates; and P′ for the proportion of P communicated to the connecting rod. Put also M, for the total moment communicated to the crank in the direction of its motion, during a complete revolution; r = A B, the length of connecting rod; l, as before $= 2 \cdot b$ C, double the throw of the crank or length of stroke of the pistons; and z any arc (to radius 1,) corresponding with the angle made by the crank with D C, reckoning from D, either in the upper or lower half of the rotary circle. Further let $a\ b$ represent the very small arc of the



rotary circle run over by the end of the crank in an indefinitely small space of time; $b\ c$ its *projection* upon the connecting rod, the direction of the force P′; B = the angle included between $a\ b$ and its projection $b\ c$; and m the angle included between $a\ b$ and the direction of the motion of the crank, that is, between $a\ b$ and the tangent at b.

Suppose now P′ the power communicated to the connecting rod, impress upon the end of the crank the very small motion $a\ b$, and R such variable resistance as would, if applied to the end of the crank directly in opposition to the motion of the crank, keep the force P′ in equilibrio. Then agreeably to mechanical principles, the moment of the virtual velocity of P′ is equal to the moment of the virtual velocity of R, or since $b\ c$, the projection of $a\ b$ upon the direction of P′ is the virtual velocity of the former; and $b\ a \cos m$, the projection $a\ b$ upon the direction the resistance, that of the latter we should have

$$b\,c \cdot P' = b\,a \cos m\ R,$$

and consequently, since $b\,a \cos B = b\,a$ and cosine of the indefinitely small angle m is $= 1$,

$$b\,a. \cos B \cdot P' = b\,a \cdot R,$$

for the relations of the power and resistance which must subsist during a single impulse of the power, while the crank is running over the extremely small arc represented by $a\ b$.

Now a state of continued motion and of equilibrium, like that which actually subsists in practice, is nothing more than a continued succession of *impulses* similar to the above; and would evidently be resolved, when all the values which the equation of momentary equilibrium would give, during an infinite number of successive impulses of the power have been collected together. In my judgment, a problem of this nature must elude every other mode of investigation but that sketched in my previous communication, to which I have already alluded.

Our reasonings so far, have been with reference to $a\,b$ as a very small finite arc; but that arc is in fact, nothing else than the *differential* of z and we may accordingly write $dz \cos B \cdot P' = d\,z \cdot R$, instead of the last preceding equation. Taking the integral of the second member, we have integral of $dz\,R = z \times$ mean of all the values of $R \cdot = z \times$ the uniform amount of resistance to motion presented by the load at the end of the crank, $= z \times$ mean pressure communicated to the crank, in the direction of its motion. Because the variable momentary resistance R equilibrating continually the momentary impulses of the power does, of course, by that condition, coincide also in amount of resistance at all times with the amount of power which has been expended effectively upon the crank; and if it did not, periodically at least, and at furthest on the termination of each revolution of the crank, also afford a mean result agreeing precisely with that uniformly presented by the load moved; the velocity of the crank would be accelerated or retarded, indefinitely, instead of performing consecutive revolutions in equal times, which is the actual state of things. Accordingly we should have $\int d\,z\,R = z\,p'$ and consequently

$$\int d\,z \cos B\,P' = z\,p',$$

which shows that the integral of the first member of the equation of momentary equilibrium determines the amount of moment communicable from the pistons to the crank, etc. It is therefore only further requisite to settle the limits between which the same mean amount of moment will constantly be reproduced upon the crank, as would be produced during any number of revolutions, and intigrate this expression accordingly, in order to determine what amount of moment is regularly communicable from the pistons of an engine to the end of its crank, etc.

With this view let the mutations in the expression of the momentary effect be traced throughout the revolution of the crank. We see, for instance, that at the point D, the beginning of the forward stroke, $\cos B = \cos 90^\circ = 0$ indicating what is manifestly the fact, that in that position of the crank, the whole power is expended non-effectively. This is technically known as "a dead point." Tracing it onward it will be seen to increase continually with the advance of the piston, until arriving at the point M, where A B becomes tangent to the rotary circle, cos B becomes a maximum, to wit $= 1$, indicating that in that position P′ has its greatest possible effect upon the crank, and the power consequently nearly fully effective. The magnitude of cos B decreases continually from this point onward, till arriving at D′, we have again $\cos B = \cos 90^\circ = 0$, and the power of course becomes a second time in the progress of the stroke entirely incapable of any useful effort. This is also a "dead point."

Hence it is clear that cos B may be expressed each way from the point of maximum to the terminal points of the stroke, by a single function of z and the data. But the projections of dz fall either within or without the rotary circle according as it is taken upon one or the other side of M; and from this circumstance take very different numerical values, in similar positions, upon either side of that point. Two functions, then, become requisite to express cos B while the crank is in the upper half of its revolution; and each of them of course requires separate intigration over the extent to which each function applies.

A similar series of mutations takes place on the return stroke of the piston, while the crank is performing the lower half of its revolution; and distinct functions are here required, since the projections of dz do not correspond in this half with those directly above; but, falling reverse ways in reference to the rotary circle, will be seen to have different values from those immediately above them. The two required have also to be integrated seperately over the extent to which each applies. The amount of effect produced then in the forward, is not exactly reproduced on the return stroke; nor is that produced forward of the points of maximum in either, reproduced in the after part of the stroke; so that it is impracticable to arrest the integration sooner than the close of a full revolution of the crank.

With regard to the immediate functions required, simple geometric relations give the following equivalents of the angle represented by B: viz.

1° for the arc D M, $(90 - m) - \sup$ of $\sup(z + A) = \text{co.}\, m - (z + A) = B$.

2° " M D′, $(90 + m) - (\sup z - A) = m + (A - \text{co.}\, z) = B$.

3° " D′ M′, $(90 - m) - \sup z - A) = -m + (A - \text{co.}\, z) = B$.

4° " M′ D, $-(90 - m) + \sup(z + A) = m + (\text{co.}\, z - A) = B$.

So also with regard to P′, the revolution of P the power actuating the pistons into components along and at right angles to A B, gives P cos A = P′ for the variable proportion of the power actually communicated to the connecting rod.

NOTE 1. The fact above mentioned proves the necessity of entirely new researches upon this subject; but it may be here noted, in passing, that, even allowing the state of things *assumed* by J. A. Roebling, (R. R. J. vol. 4, page 162.) to agree with that which *actually exists* wherever the crank is employed in connexion with the steam engine, it is still liable to this objection; the same process of reasoning he employs applied to his effective ordinate would give for the effect produced .2146; and thus we should have this remarkable state of things—to wit: but 1 part lost and 1 part effective out of 5 of power actually expended! or 4 parts lost and 4 parts effective out of 5 parts of power expended, each and all at one and the same time!

(To be continued.)

For the American Railroad Journal and Mechanics' Magazine.

The following graphic description of the *advantages of a railway compared even with a river, for transportation and travel* is the sober report, of "a joint special committee of the legislature of Massachusetts."

The period is near at hand, when our legislature should entertain the neglected subject of railways, and fix on some *system* by which the State and its treasury will not be cursed with unprofitable works, commenced and pursued with perseverance by designing politicians. I am gratified to find by your last number, that "*Fulton*" has thrown out a plan for consideration, which if adopted, will have one great advantage, and save the State millions on millions. I mean, the support by the State to *private enterprize*, where individuals show confidence in their own projects, by *first* disbursing their own means to the extent of two-thirds of the cost of the proposed work, to entitle the projectors of a railway, to a subscription risk by the State of one-third its cost. The State should appoint one-third of the directors; with this check, there will be no fear that their money will be squandered. Not so with works undertaken and managed by the State, or general government. Witness the Columbia railroad in Pennsylvania, where 80 miles have cost upwards of four millions of dollars badly located, with inclined planes on a line, that will be superceeded by the Philadelphia and Reading railroad. The State furnish the *motive power*, on the Pennsylvania railroad, whilst individuals furnish the cars, and charge higher for transportation, than any railroad within the writer's knowledge in the United States.

As another instance of extravagant expenditure by the general government, look to the Cumberland or National road, abandoned by general consent, from its cost, government patronage, etc. etc. The ground is yet, almost too hallowed to touch on canals made by this State. This arises from our success with the Erie Canal, owing to its peculiar location, connecting as it does a rich State and inland seas with the ocean. The period, however, has arrived, to stop the extravagant expenditures in this State, on any new canals, and the sooner we razee the expenditure on the enlargement, untill sane men prove that it is needed by the present generation—the better it will be for our tax-paying proportion of the community. The Black River, Genesee, and Chenango canals, will share the fate of the Blackstone, Middlesex and Farmington. Railways will superceed them. J. E. B.

"Railways universally have created the means of their own sustenance, and have drawn to their tracks employment for their motion. If the beneficence of Providence had hollowed a channel from our coast to the western lakes, and poured the floods of those inland seas eastward to the ocean, the blessings would have been too great for sufficient gratitude, as they would have been beyond all computation. The river, swelled by tributary streams from every valley, would have scattered wealth along its course. For all practical purposes, the invention of art bestows better advantages, and furnishes communication more easy and certain than the bounty of nature could give. During the stern winter of our climate, the rivers are closed for one-third of the year with ice; in summer, they are exhausted for a nearly equal period; their navigation is bounded by the hills that supply their fountains. The railroad is neither locked by cold, nor dried up by heat, nor confined by ridges. Stretching out its arms to every town and village, it may be extended beyond the highland barriers of water passage, and beyond the lakes, until its iron bands clasp together in a net-work of improvement overspreading the whole Union."

For the American Railroad Journal and Mechanics' Magazine.

PLAN FOR CONSTRUCTING RAILROADS. Proposed By *John A. Roebling*, Civil Engineer.

Fig. 1.

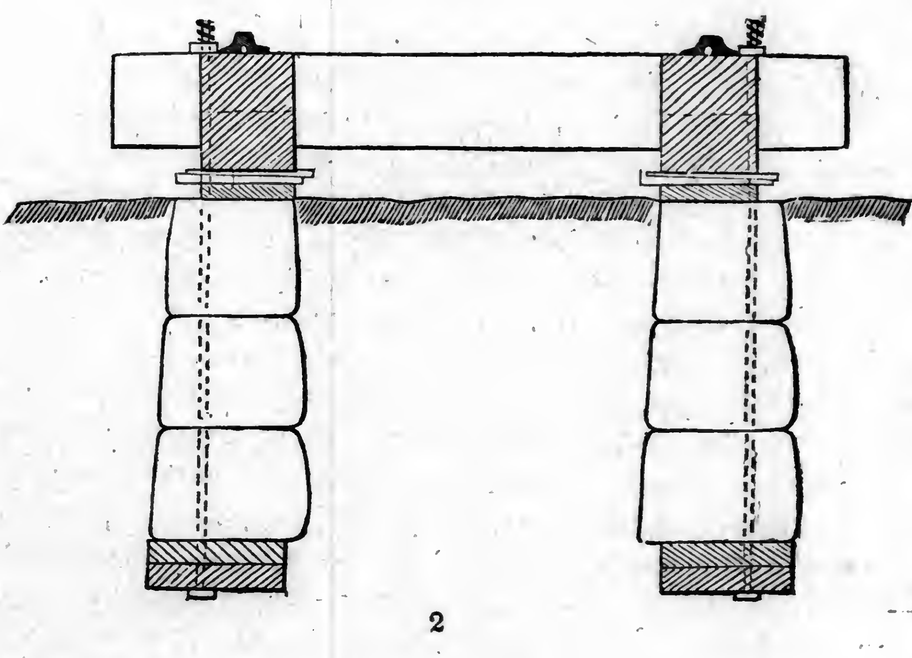
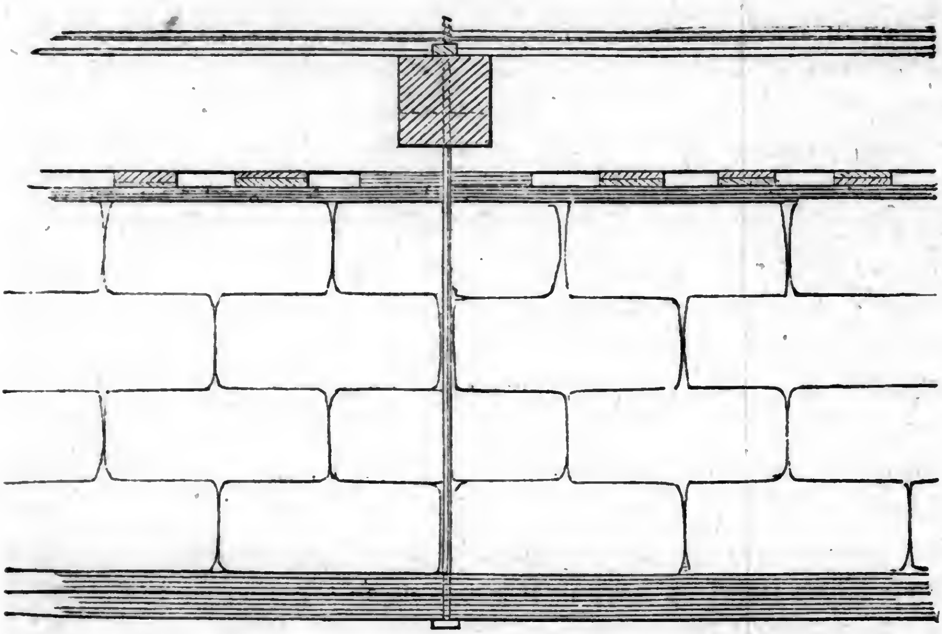


Fig. 2.



The friends of railroads are still in search of a mode of construction, which will form adequate tracks for the successful operation of our improved locomotives. Many plans have been tried and tested for years; none, however, appears to have succeeded so as to deserve a preference before all others. The same diversity of opinion, which exists here as to the best mode of construction, prevails also in Europe.

In order to be able to adapt a construction most successfully to the object, for which it is intended, it becomes first necessary to investigate the principle of its action. I do not pretend here to offer any thing new; I wish only to draw the attention to some points, which appear to deserve most consideration. One of the first conditions of a railroad superstructure is, to offer sufficient resistance to the vertical action of the ponderous machines, which are to move over it at high velocities. The ordinary mode, which to a great extent has been practised in the United States, of supporting the flat bar iron upon longitudinal timbers and these upon cross ties, which again rest upon longitudinal mud-sills, did never give satisfaction. By this system, unseasoned, and otherwise unprepared timber is in large quantities buried into the road-bed without any further provisions of preventing the timbers from settling irregularly, or from being upheaved by the frost. The timber is moreover placed in a situation which favors a speedy decay. Modifications of this plan have been tried with some better success, still they leave much to improve yet. Stone block have also been used as foundations for continuous bearing timbers. This was evidently an improvement, but not sufficient. A favorite mode of superstructure for the T rail was and is yet, to support this rail by sleepers or cross-ties at intervals, and to rest the sleepers loosely upon mud-sills. This mode of construction appears to be the worst and weakest of all. The tolerable good success, which some of these roads have had, should not be attributed to the manner of supporting the rail, but the greater rigidity of the same, resulting from its improved form and increased weight. The facility of repairs in substituting new slippers in place of the old rotten ones, speaks in favor of this system; but the frequent necessity of such repairs is just one of its chief faults. While such a road is working, it is all the while making. On all these roads are the foundations which are either timber or stone, not laid deep enough to resist the action of the frost, nor are they sufficient when the road-bed is softened by incessant rains. Foundations of broken stone have to be made very thick, to be of any service, and then they do not offer a uniform support.

There is a difference of opinion with respect to the immediate support of the iron rail. Flat bars have been found too insufficient and are nearly abandoned. In speaking of rails therefore, we mean edge rails or bridge rails, of the different forms. A support of the iron rail is necessary. The nearer the supports are, the less the rail will deflect vertically. A continuous support will therefore be the best. The views of those Engineers who are still in favor of supports at intervals, are neither corroborated by experience nor theory. The best material for the immediate support of the iron rail appears to be that, which with the necessary solidity for supporting pressure, and stiffness, unites sufficient elasticity, to counteract the impetuous effect of the great vertical pressure and concussions of the heavy engines. Stone as immediate support is too rigid a material; it has too little elasticity and is too unyielding. Felt is therefore introduced between the chairs and stone blocks, where such are used. By far the best material appears to be wood, as intermedium between the iron rail and the stone foundation. Timber will therefore always form an important material in the construction of railroads, even where an abundance of the best stone blocks can be had. Not only the effect of the intermediate timber upon the foundation is advantageous, but all the railroad machinery will run easier on a rail, resting upon timber, than on one resting solely on stone. The tremulous motions and vibratory concussions will be less on a timber support than on a stone support.

Timber can be had in the United States cheap and in abundance. Not so in Europe, where iron is often substituted in its place. Here iron rails of less weight will suffice, if the continuous bearing timbers are strong enough.

The question now arises, when timber is used in the construction, at what place should it be applied in the greatest mass? In answer, it appears to me, that the continuous bearing should be made as strong and large sized, as timber can be had at *moderate prices*. The practice of using sawed scantling of 5 by 8 inches and the like for bearings, has every thing against it, and will always make an insufficient road, unless the iron rail is very heavy. How can we expect from such sticks, to support quietly the tremendous weight of a rapidly rolling engine of heavy character? It is impossible.

In order to support great concussion, we must offer a massy and compact resistance. Although a framing or connection of scantling may contain as much quantity as a single heavy timber, yet the latter will resist all shocks and concussions more successfully than the former, because in the single timber, the material is united, and resists in a mass; in a connection of scantling however, the upper timber has to bear the first effect of the concussion solely, and can only transmit them to the rest below.

This view will be made clearer by the following illustration: A strong man stretched upon a floor, may support an anvil on his chest, while iron is hammered on it with sledges. One single stroke with the sledge hammer, executed upon his bear chest, immediately, would break his bones. But through the medium of the heavy and massive anvil, he is enabled to support a succession of blows unhurt.

The same principle may be applied to railroads. A heavy piece of timber is required for the immediate support of the iron rail, in order to sustain the first effect of the concussions, produced by the engine, and to transfer them to the foundation less injuriously. Or the iron rail must be very heavy instead of the timber. But wood is cheaper than iron. Instead of increasing the weight of the iron rail a few pounds per yard, we may increase the size of the timber considerably, and preserve it too. Another important advantage of a heavy continuous bearing is, that the weight of the load, which rests on a single point of the rail, is distributed over a greater extent of foundation in consequence of the stiffness of the timber.

The means we use to support heavy masses, must be also massive in their nature, if they are to answer the purpose. The greatest resistance should be where the exposure is greatest. Now the lateral motions, which are produced upon the rails, are far less than the vertical motions, less provisions are therefore required to counteract them. Heavy continuous bearing timbers of 12 inches by 15 inches, have in itself, lateral strength enough to require no more ties, than one of 12 inches square every ten feet. Thus the number of pices is reduced and the construction and repairs simplified.

By the old system of supporting the edge rail on a sleeper every 3 or 4 feet, the number of pieces is multiplied. There they are necessary to support the rails. This support extends however only to a little distance to the side of the rail, as the small dimensions of the ties will make them bend, if the foundation below the rail yields. Any timber therefore between the rails, that is not necessary for binding the track horizontally, is uselessly applied, as it will not serve as vertical support *efficiently*. The material for vertical support is most needed under the line of the rails, and outside of it *no more timber should be used than is required for lateral strength.*

The next important object is a proper foundation for the continuous bearing timbers. Nothing less appears to me to answer the purpose fully, than a regularly built dry wall, made of large stones with good beds. A stone filling between the rails or outside will not increase the vertical strength of the work, it can only prevent the lateral displacement. This however can be effected in another manner, as will be shown below.

The walls should extend 4 feet into the road-bed, so as to be below the reach of the frost or nearly so. They should rest on planks, which will prevent their settling unequally. Such provisions appear to be sufficient for the support of heavy loads.

But another effect of the railroad machinery upon the road has to be guarded against, and which is one of the most destructive in its consequences. This is the *recoiling* and *springing* of the superstructure, after the heavy weight, which depresses it, has passed over. Although this sinking and rising of the continuous bearing may be hardly perceptible at the commencement, it will increase and become a fruitful source of destruction in its consequences. A road may be perfect in all other respects, but if no provision is made, to prevent the rising of the construction, it will become deranged. But how is this to be avoided?

Mr. Brunel, it appers, was the first engineer, who has duly appreciated this great source of derangement and has on the great western railroad, in England, caused transom timbers to be bolted to piles, and which serve the double purpose of supporting the rail timber as well as prevent them from rising. The rail timbers are bolted upon the transoms, and the piles are driven deep enough to resist the pressure from above as well as below. Although this plan serves the object for which it is intended, it will hardly be imitated in this country in all its features. The principles by which Mr. Brunel was guided in adopting that mode of construction, appear to be correct.

The objeot of securing the track downwards, may also be attained, by anchoring the wooden ties, which may be 10 feet apart, by means of iron rods, to the planks on which the walls rest. These anchors may be about one inch thick, round iron, have a head at the lower end and a good screwthread at the upper end. The wooden ties are then held down by means of plates and screw nuts. The rail timbers should not rest immediately on the walls, but on planks inserted between. Another space of two inches is then left between these planks and the rail timbers, which serves to drive in flat wooden wedges, for the purpose of forcing the rail timber up and the foundation down. The wedges are to be made of the hardest wood and driven in from both sides. The track can be very nicely adjusted by means of the wedges and screws. Thus the whole superstructure and walls are firmly united into one. The great weight of the mass will prevent all springing. The firm anchoring will also prevent lateral motions to a great extent. All future inequalities of the track are to be adjusted by screwing and wedging.

Diagram No. 1, at the head of this communication show the cross section of such a construction as proposed. Diagram 2 shows a side view.

The walls in the side view are assumed 4 feet deep, with a base of 21 inches, top 15 inches and a batter of three inches on each side. The foundation planks are laid double and 16 inches by 3 inches. About the anchors the best stones are used. In the first and fifth course the stones meet at the anchor, in the second and top course, grooves are cut in the stones to allow the free passage of the anchors. If not the whole of the timber is to be preserved, the foundation planks, which will be out of reach, should at least be secured from decay. The rail timbers are 15 inches by 12 inches. The cross-ties are supposed to be 10 feet apart from centre to centre and 12 inches square. The iron rails are of the bridge rail form, which suits this superstructure best. An improvement would be to screw straps of hard wood upon the rail timbers and fix the rails upon the straps, as is done on the great western railroad. If the iron rails are 20 feet long, the rail timbers should be either 20 or 30 feet long. Where two timbers meet, they are to be notched half their thickness, the notches for the intermediate cross ties, however should be only 4 inches deep. The upper corners of the rail timbers may be champered off. The heads of the anchors rest against a plate of sheet iron. Another plate is placed under the screw nut and so formed as to fit on one side upon the web of the iron rail. The bridge rail is firmly fixed *in its middle* by two screws upon the rail timbers, and not upon the cross tie, where two timbers meet, so, that a screw is driven in each end of a timber a few inches off the tie. The other extent of the iron rail is secured upon the timber by spikes or screws so that the iron is allowed to expand and contract. The same plate which is laid under the screw nut of the middle anchor, supports also the rail ends. This plate may be cast with 3 projections. One projection in the middle serves for the purpose of fitting in the grooves of the rail ends, and thus securing them laterally. The others serve to confine the web of the rails. This plate is let into the wood. The screw plate of the anchor holds the webs of the rail ends down on one side, and on the other side two other screws or spikes are driven. Thus the rail ends are sufficiently secured.

On embankments the anchor screws should be made long enough so that the rail timbers can be raised to the proper level, after the embankment has become solid. Another course of stone or timber is then to be placed upon the wall under the rail timber. Where the road-bed is formed in excavation of a slaty and porous nature, there it may not be necessary to sink the walls 4 feet low, as such a road will be naturally dry and not much effected by frost. The forming of ditches for walls in solid excavation would be too expensive. In that case I would recommend neither walls nor anchors, but a coupled rail timber in place of a single one, resting loosely upon the solid road-bed. A stone filling would in such a case be necessary to prevent lateral displacement.

Where the walls are sunk low enough and the anchoring is firm, a stone filling between the rails appears unnecessary. The superstructure and the walls will be so strongly united, that the great friction will prevent any lateral displacement. If a stone filling or ballasting should be found advisable, it should not be put in before the whole work is settled and re-adjusted. The wedging could afterwards be only performed from outside.

The last adjustment should be effected in the following manner. A locomotive of the heaviest class is run upon the road and its weight upon the driving wheels increased one half at least. This can be done by throwing the weight of the tender on it, and by loading the platform before the fire box with additional weight. While this heavy load rests upon the rails exactly over a tie, the anchor screws are drawn tight, if the rails are too high. While this engine is running slowly back and forward over a short extent of the road, it is observed, if the rails are depressed or remain firm. By alternate tightening or easing the wedges and screws, the whole construction will be forced into a compact union, which cannot be seriously effected by any future action of the locomotives.

If so adjusted and strengthened, it may reasonably be expected, that such a road will present a perfectly smooth and regular track, on which the railroad machinery will ply in the easiest manner and without any jolting and jerking whatever. It is even thought that the firm anchoring will not admit any derangement by the frost. A slight re-adjustment, however, in the spring of the year by tightening the wedges, will be attended with little cost.

The above plan is not suggested with the idea of offering any thing like perfect. I wish it to be considered merely as a contribution to the general stock of practical means and ways already in use.

The great objection to such a construction will be its cost. But since we cannot form a good substantial road without great cost, it will be good economy to go to a heavy expense at once at the first outset, and avoid endless repairs in the future. Such a road will then be found the cheapest in the end.

Would it not be better, instead of grading roads for a double track, where there is not sufficient business to be expected the first 20 years for a well managed single track, to form the bed only for one track with suitable turn-outs, and to expend the money, thus saved, upon a good superstructure?

Paradoxical as it may appear, it can be practically demonstrated, that *with a moderate business*, a single track, well regulated and managed, will afford as much safety as a double track. A single track, when managed improperly, will not work at all. Therefore a thorough going system is indispensably necessary; and if adhered to at all times, it will fulfil all the conditions of a second track.

For the American Railroad Journal and Mechanics' Magazine.

THE LAWS OF TRADE APPLIED TO THE DETERMINATION OF THE MOST ADVANTAGEOUS FARE FOR PASSENGERS ON RAILROADS. By *Charles Ellet, Jr. Esq.*, Civil Engineer.

If any explanation were needed for the publication of this paper, it is probable that a sufficient one might be offered in the fact that the railroads now constructed, and in progress of construction, in this country, will cost from two to three hundred millions of dollars; and that the tariff of charges are nearly always the result of the most vague conjecture, and frequently such as greatly to reduce the revenue which they might be made to yield.

The writer has elsewhere exposed the incorrectness of the present method of assessing the charges on heavy tonnage, and endeavored to offer the means by which, it is believed, the proper rates may, on that part of the business of the work, be determined with great certainty. The present paper is intended to extend the application of the same principles to the matter of fares for passengers on railroads; a question which is equally susceptible of being subjected to a process of accurate reasoning, and which furnishes equally correct premises for the foundation of the argument. And if these premises have been justly assumed, and the conclusions fairly deduced, it may be averred, without risk of exaggeration, that the neglect of the results obtained from them, induces a loss to the proprietors of the railroads in this country alone, amounting annually to several millions of dollars.

The establishment of the tariff for an important improvement, is a momentous question for the company; and one which requires as careful an investigation of the facts, and the exercise of as much sound judgment, as any other which the engineer is likely to encounter in the course of his professional practice. The most consummate skill may be applied in the location and construction of the work and its appendages, and the entire success of the enterprise may still be marred by the subsequent injudicious administration of its affairs

But it is not for the computation of the charges only that an attention to the requirements of the laws of trade is essential to the prosperity of the undertaking. In deciding on the character and location of the work, and adopting a system of transportation, it is equally imperative. It is as impossible to select the most appropriate plan of construction, and make choice of the most advantageous location, without a proper regard to the amount and nature of the business to be transacted, as it is to assess the charges without an attention to the cost of freight, and the value of the article to be conveyed. A road intended for the accommodation of a trade of 100,000 tons, or passengers, will generally be placed on very different ground, and ought always to be built in an entirely different manner, from those which would be adopted if a trade of but 10,000 tons were anticipated. In both cases, the inequalities of the natural surface must be more or less removed, for the purpose of reducing the expense of transportation; but the outlay justifiable for this object is wholly governed by the value of the object, which is dependent on the amount of trade. The heavy excavations and embankments are made for the purpose of reducing the price of freight; and if the trade be 100,000 tons, it will be worth 100,000 cents, or 1000 dollars, per mile per annum, to reduce the cost of transportation one cent per ton per mile. This sum is equivalent to a capital of some 16,000 dollars—the expense which might be incurred on each mile of a road of such expectations, in order to reduce the freight the amount designated. But if the trade is to be only 10,000 tons, the same object, by this reasoning, would only justify an outlay of about 1,600 dollars; and consequently the road intended for the light trade would, of necessity, be placed on very different ground from that which would be chosen for the other.

The outlay should never be more than commensurate with the object for which it is incurred; and therefore, the first and most important data to be plovided by the engineer, in the incipiency of the enterprise placed under his professional guidance are, the value of the object contemplated by the undertaking—the amount of the trade expected to be accommodated—and the extent of its dependence on the arrangement which he dictates; data which can only be obtained and appreciated by an attention to the laws to which the trade is subject.

The prosecution of these considerations will lead at once to the conclusion, that incalculable sums of money have been sunk on the improvements of this country, in reducing the irregularities of surface on works of small pretensions. That on such roads the grades ought to be comparatively steep; tunnels, deep cuts, and all similar expensive works should be avoided; and the hills and valleys, for the passage of which they ase designed, should be crossed by increasing the acclivity of the grades and the length of the line. The superstructure, also, both of wood and iron, as well as the location, should be adapted to the trade; and the dimensions and weight of the engines and cars should be governed by the same considerations, and adapted to the intention of the road, and the character of its superstructure.

If the trade be great, the road must be made to correspond with it; and the foundation may then be immovable; the rails of iron, the track of great width, the acclivities gentle, the velocity slow, and the weight and power of the engines adequate to the movement of the heaviest trains. In the former case, the size of the engine might be limited to two or three tons; and in the latter, it may be extended to twenty or thirty. The cars on the light road may be made for the accommodation of eight or ten passengers; and on tho other, if we choose, they may resemble moving palaces, and be provided with almost all their comforts.

All the arrangements must be subject to the control of the real or anticipated trade; and the character of the work, as well as the administration of the affairs of the line, must depend on the application of the principles which we have attempted to develope under the appellation of the "Laws of Trade." Our present study relates to the latter department—the administration of the line, in reference to the question of

The Fare for Passengers on Railroads.

The principles which have served for a guide to the results announced in the preceding articles, are not less useful in the determination of the charges proper to be levied on railroad passengers. There are, however, difficulties to be encountered in this division of the subject, which do not always obtain in the discussion of the laws which govern the trade in heavy commodities of small value, previously considered; and which, though they cannot be thought to leave the general results at all exceptionable may render the employment of the formulæ embarrassing in some particular applications. But yet, it is believed that by the division of the whole subject between the question which has for its object the calculation of the charges proper for particular lines, connecting important places, and the wider problem, to determine what should be the fares common to several connected railroads, that their aggregate net revenue may be the greatest possible—it will be relieved of many of its difficulties.

In reflecting on this problem, the first inquiry which presents itself is, what are the circumstances which govern an individual in deciding on the propriety of undertaking a journey? for if there be no law to which his decision is subject, there can be none to govern the charges exacted for his conveyance. But, fortunately for our purpose, there is one very important consideration which, in this commercial age, appears to control all the enterprises of man in civilized society, and to the application of which there can be no exception made in favor of his travelling propensities. This is the consideration of *cost, or hope of gain.* The profits of business, curiosity, or the prospect of pleasure, incites to embark on the voyage; and the *cost of the journey,* whether it consists of the value of his time, the importance of his personal attention to his home affairs, the desire to yield to the dictates of indolence, or the amount of his travelling expenses, urges the party to remain. He reflects on these opposite considerations, and forms his conclusions; and the result is, with very few exceptions, that he cannot afford to set out if the cost of stage *fares* will exceed a given sum. They who are to transport him have no control over any item which enters into his computation of the cost, but this; he puts his own estimate on the value of all the other considerations, and balances the account as his judgment and feelings admonish. And his final conclusion depends on the comparison of the sum which he thinks he can afford to pay for his fare, with that which the companies are disposed to exact. It matters not, for our present purpose, what this limit, which he chooses to prescribe for himself, may be—whether it amount to one dollar, or to twenty dollars—providing it be admitted that there is a sum to which each individual, after considering all the circumstances—all the charges—the advantages sought, and the inconveniences to which he will be exposed, limits the amount that he will rather pay for his fare than decline the trip.

An individual thus situated is in precisely the same condition with reference to the proposed excursion, as an article of merchandize in which he trades; there is a certain sum which may be charged for his conveyance without excluding him from the route; he will go if he is charged no more than that sum, and if charged more he will remain;—just as he will send his corn and lumber to market, if the charge for their conveyance will authorize him to do it, or retain them in his warehouse or in his for est, if the charge be higher than he can afford to pay. He makes the same sort of calculation with reference to his journey as that which he institutes in deciding on the propriety of shipping his goods.

And if we were now able to separate the public into classes, and fix appropriate values on these classes, to represent the charges which they could afford to pay—as we can separate and value the different varieties of tonnage—the problem would be readily solved; for we would have then only to apply the equations already deduced for heavy tonnage,* to each class, by inserting in the formulæ the ascertained values of π, and obtain from them as many correct results as we should find varieties in the travelling community. But in the present case, we cannot proceed in this way, since we are compelled, by the constitution of society, to charge all—or at least all who receive the same accommodation—alike; and consequently, before the formulæ could be employed, it would be incumbent on the company to find, among all these infinite grades, that one which, if made the basis of the tariff, would yield the highest revenue. The company do not, however, know whether the value which represents this particular grade is a constant quantity, or whether, as appears probable, it may not be a function of the distance, or otherwise complicated.

To avoid these difficulties it will be necessary to pursue a different route; and assume, as authorised by the preceding remarks, that in every town on the line, or in every square mile of the country, there is a certain number of persons who can afford to make an excursion to some given point on the railroad—as the great city from which it issues—providing the cost of the trip shall not exceed a given sum. That there is another number that can afford to pay twice that amount—others three times that sum, and so on, until we arrive at the limit which would almost preclude travelling. We will also assume that the number of individuals in each of these classes is the same; or that there are three times as many who cannot afford to pay three dollars as there are of those who are unable to pay one—the number of persons excluded being directly as the sum which represents their grade; or, it may be assumed that for every increase of the cost of reaching the point in question, the number of passengers will be diminished; and that the diminution of the number will be proportional to the augmentation of the cost.

The investigation, based on these premises, will embrace two distinct cases, which appear to be the most important that are likely to be encountered in the course of the application of the principles to practical purposes. The business of the line will be assumed to be constituted either of the travel which proceeds from the large cities on the route, and which usually form the termini of the works of the separate companies; or of that which is thrown upon the main trunk by tributaries of greater or less consequence.

* Essay on the Laws of Trade, p. 63—6.

This discrimination is prompted by the consideration that it would seem proper for the separate companies to regulate the charges to be exacted of those who traverse their respective lines only; but that the rates to be levied on the distant traveller, who purchases his ticket and pays his fare "through," should be adjusted by the co-operation of all the parties. And the questions proposed for solution are: 1st. To determine the proper charges to be exacted of those who proceed from the cities on the line of the road, and who, for the most part, will pay over one line only; and 2d. To ascertain the law which should govern the prices to be paid by passengers who are brought to the principal route by its tributaries. These questions are too complicated to be treated without the aid of mathematical formulæ, and we will therefore designate by

π the greatest charge for conveyance which any grade of passengers can afford to pay;

ϵ the gross charge per mile on the railroad;

δ the freight or actual expenses per mile per passenger on the railroad;

c the toll or clear profit per mile per passenger on the railroad;

β the charge for conveyance, per mile, on the tributary;

h the distance from the assumed origin to the tributary.

Now, it is obviously proper to assume that if the fare on the road connecting two cities, as Philadelphia and Baltimore, were reduced to zero, and the public were carried free of charge, the number of travellers passing over the road, exclusive of those brought to the line by tributaries, would be some constant quantity, T; and it has already been assumed that for every increase of one cent in the charge, the number would be reduced some quantity represented by the co-efficient, t. The whole number of passengers proceeding from these cities will then be expressed by the equation.

$$T - \epsilon\, h\, t; \qquad (1)$$

since $\epsilon\, h$ is the gross charge between the two places. The clear profit which will be derived from the transportation of this number of persons will then be represented by

$$(T - \epsilon\, h\, t)\, c\, h;$$

a quantity which will attain its maximum value when the condition imposed by the equation.

$$c\, h = \frac{1}{2}\left(\frac{T}{t} - \delta\, h\right), \qquad (2)$$

expressing the charge on each passenger, exclusive of the actual expenses, is fully satisfied.

If to this quantity we add the actual expenses, $\delta\, h$, we shall obtain for the proper value of the gross charge.

$$\epsilon\, h = \frac{1}{2}\left(\frac{T}{t} + \delta\, h\right). \qquad (3)$$

From which we conclude that under the circumstances assumed, the gross charge which will yield the highest revenues on all the travellers who pass between the two cities, at which they reside, will be obtained by *adding half the actual expenses to a certain constant quantity.*

The value of this quantity can readily be obtained by experiment. For this purpose we are to note the reduction of the number of passengers produced by any augmentation of the fare; from which we derive, by supposing the increase or decrease of travel proportional to the variation of the charges, the reduction caused by the whole charge $\epsilon' h$. This reduction, added to the number actually obtained under that fare, will produce the value of T; and consequently of the fraction $\frac{T}{t}$.

Now, the only objection to this argument is the assumption that the diminution of travel is proportional to the elevation of the charges on the line; a postulate which cannot be proved to be correct.

Indeed, it is probable that a given variation of the charge would produce very different values for the co-efficient t, at the extreme limits of the sums designating the elevations of the grades. But it is to be recollected that the equation can never be applied at these limits; since in practice the charges can never descend as low as δh, or the actual expense of conveyance, nor ascend as high as the sum which would justify the establishment of a rival. The space through which the charge can possible range, is confined within certain bounds, not very well defined, it is true, but still, sufficiently restricted to destroy the chance of any material error arising from this source. And consequently within these bounds it appears safe to assume that the *increase* or *decrease* of travel (not the travel) will be proportional to the elevation or depression of the charges.

According to the form of equation (1) there is a certain charge for conveyance so high that, if exacted, passengers would be entirely excluded, and we should therefore have, $T - \epsilon h t = o$; from which would be immediately deduced $\frac{T}{t} = \pi$, the value of the highest grade in the community.

In fixing on the sum which represents the ability of this highest grade, if we choose to make use of this expression, we should not, of course, be governed by the occasional passenger whose wealth will authorize him to pay almost any sum for the gratification of his fancy. The expression cannot be extended beyond the class of which the number is sufficient to contribute materially to the support of the work. It is not, however, essential to the attainment of the greatest income that the determination of this point should be very accurate; and for the object now in view—the discovery of the proper method of graduating the tariff—it is a matter of still less consequence.

In passing to the second, and more important, problem which we have proposed to investigate, we will assume that when the charges for fare both on the main line and its tributary, are zero, the number of passengers received from each mile of the latter will be represented by any constan quantity T; and that for every increase of the whole cost of conveyance to the place of destination, amounting to a unit of price, the number of passengers will be diminished the quantity t; we shall then have, for the reduction of the number of passengers furnished by any increment of space $d\,x$, situated at the distance x from the main line, due to a charge ϵ per mile for fare on the railroad, and β on the tributary,

$$(\epsilon\,h + x\,\beta)\,t\,d\,x;$$

and, consequently, for the differential of the whole number supplied by the tributary, the expression

$$d\,\mathrm{N} = \mathrm{T}\,d\,x - (\epsilon\,h + x\,\beta)\,t\,d\,x.$$

The intergral of this expression will represent the whole number of passengers, of every grade, supplied by the space consisting of x miles, measured from the main line along the tributary; and we shall therefore obtain by performing the integration, for the value of this quantity

$$\mathrm{N} = \mathrm{T}\,x - \left(\epsilon\,h\,x + \beta\frac{x^2}{2}\right)t. \qquad (4)$$

Now, the highest grade of passengers supposed to come on the work by the branch in question, as we have already seen, is $\pi = \frac{\mathrm{T}}{t}$; or the grade which renders the quantity $\mathrm{T} - \pi'\,t$ equal to zero. And if we deduct from this value of π, the whole charge for conveyance on the main line, the remainder, $\frac{\mathrm{T}}{t} - \epsilon\,h$ will stand for the sum that the portion of the community represented by π can afford to pay for conveyance on the tributary after paying the charge on the main line.

The distance which this grade can afford to travel on the tributary, will be represented by the quotient obtained in dividing this sum by the charge per mile for conveyance on the tributary—a quotient which is expressed by the equation

$$\frac{\frac{\mathrm{T}}{t} - \epsilon\,h}{\beta} = x.$$

If we now substitute this value of x in the above value of the number of passengers furnished by the tributary, we shall obtain the new equation

$$\frac{\mathrm{T}^2}{2\,\beta\,t} - \frac{\epsilon\,h\,\mathrm{T}}{\beta} + \frac{\epsilon^2\,h^2\,t}{2\,\beta} = \mathrm{N}, \qquad (5)$$

relieved of the quantity x, and completely expressing the number of travellers of all grades, destined to the assumed origin, thrown upon the railroad by the tributary under consideration. And if we now multiply this quantity by c, the toll or clear profit per mile, and substitute $\delta + c$ in place of ϵ,—differentiate the expression, and place it, as required by the rule, equal to zero, we shall arrive at the condition represented by the equation

$$\frac{\mathrm{T}^2}{3\,h^2\,t^2} - \frac{2\,\mathrm{T}\,\delta}{3\,h\,t} + \frac{\delta^2}{3} = \left(\frac{4\,\mathrm{T}}{3\,h\,t} - \frac{4\,\delta}{3}\right)c - c^2.$$

This is a quadratic equation, from which we obtain, after clearing it of the radical, for the toll or clear profit to be derived from each passenger,

$$C h = \frac{1}{3}\left(\frac{T}{t} - h\delta\right); \qquad (6)$$

where the charge is understood to apply to the whole distance h, through which the passenger is carried. By adding to this quantity δh, or the actual expense of conveyance by railroad, we shall obtain,

$$C' h = \frac{1}{3}\left(\frac{T}{t} + 2 h \delta\right) \qquad (7)$$

for the gross charge which should be levied in order to obtain the highest dividend; an equation which again shows that *the whole charge which should be exacted of any passenger is a constant quantity augmented by two-thirds the actual expense of his conveyance.*

Although there are numerous subordinate questions connected with this problem, the two cases now examined cover the most important that can arise in the application of these principles to practical purposes. The equations resulting from the first will aid to frame the tariff on separate lines; while those of the second may be applied to lines of greater length, and constituted of a number of distinct interests.

It is not, however, necessary to make this distinction, unless there be sufficient reason to believe that the values of the fraction $\frac{T}{t}$ differ essentially for the two classes of travellers. This will be made manifest on a comparison of equations, (2) and (3) with (6) and (7); for we find by these expressions that both the toll and gross charge obtained for the two cases are of the same form, though differing slightly in value: and that the amount of this difference is but one-sixth the whole charge—a sum entirely too trifling too produce any appreciable effect on the revenue of the work. It is not pretended here to obtain the exact charge which would yield the highest dividend, within ten or fifteen per cent.; but it is the object to point out a method by which to avoid the common errors of such tariffs—errors which are not unfrequently five, and indeed much oftener more than ten times that amount. The loss of revenue may be wholly imperceptible when the deviation from the true charge is ten per cent.; but it must be remembered that for every dollar that is lost, on heavy tonnage, by an overcharge, or an under-charge of ten per cent., there will be experienced a loss of one hundred dollars for ten times that deviation. *The loss increases as the square of the departure from the charge which corresponds with the maximum revenue.** It is not essential to hit the exact mark, but it is exceedingly dangerous—certain indeed to be followed by great loss—to deviate too wide from it.

Such are the equations for the computation of the rates which must be

* *Essay on the Laws of Trade*, p. 152.—The increase is not so rapid in the present case, but it is still very great indeed.

established when it is determined to enforce in practice a rigid adherence to the principles which have governed the investigation. But, before proposing a rule for general usage, it will be proper to notice a modification which may be made in the formulæ, and ascertain the probable consequences of its adoption. Occasion has already been found in the course of these articles, to advert to that peculiarity of quantities which have attained a maximum or minimum limit, of being very slightly effected by a considerable increase or diminution of the value of the variable. In the question under discussion the variable which affects the amount of the revenue is the charge for toll; and, in consequence of this property, if we increase that quantity, as determined by the calculation now offered, any small amount, although the number of passengers, of the grades that are influenced by their travelling expenses, will be simultaneously reduced, the additional tax levied on the remainder will be almost sufficient to compensate for the loss due to the decrease of the number. Now, the whole charge for toll is

$$\frac{\pi}{3} - \frac{h\,\delta}{3};$$

and if we observe the form of this quantity, we will perceive that an increase of this charge equal to the second member, $\frac{h\,\delta}{3}$, would amount for any distance over which it would be possible, or desirable, to enter into a general arrangement, to a sum too small to produce any sensible reduction of the revenue. If, for instance, we assume six dollars for the value of $\frac{\pi'}{3}$ one cent per mile for that of δ, and 500 miles for the distance h—which last assumption is nearly equivalent to supposing that the arrangement is adopted by all the companies between New York and Raleigh, N. C.,—the effect of increasing the charge per passenger as suggested, the exact value of $\frac{\delta h}{3}$, would be to increase the net income per passenger, or charge for toll at that distance, but $37\frac{1}{2}$ per cent.; while it has been shown that an increase much greater than this amount, on heavy tonnage, (Art. 2,) would not essentially reduce the revenue,—and at 300 miles the increase would be but 20 per cent., and the diminution of revenue nearly imperceptible.

We would, therefore, be authorized in permitting such a departure from the formulæ by these considerations alone, if there existed no other argument in its favor; but it will be observed that the equation (6) was deduced in the hypothesis that every individual using the line is more or less affected by the charges; an assumption which, although in this country almost universally true, is not without exceptions—for it must be admitted that there is a portion, though a very small part, of the travelling community, scarcely influenced at all by this consideration. We have not the means of estimating the actual or comparative number belonging to this class; but there is cause to believe that the proportion which it bears to the whole number of persons travelling increases materially with the increase of distance. We also know that the effect of this modicum, if taken into the account, would be to augment the charge for toll; and, consequently, if allowed for in the above expression of the net income per passenger, that equation would assume the form

$$C\,h = \frac{\pi}{3} + f\,h = \frac{\delta h}{3};$$

in which, as before observed, we neither know the form nor the exact value of the junction $f\,h$—nor whether it be greater or less than $\frac{\delta\,\pi}{3}$ — though we do know that these quantities, besides being of opposite signs, are both too small to have any serious effect on the revenue. This sum might even be a positive quantity; but for reasons already adduced in justification of the neglect of $\frac{\delta\,h}{3}$, unless that positive quantity were one of very considerable importance, and much greater than the negative quantity $\frac{\delta\,h}{3}$, its neglect would have no visible influence on the revenue. We will, therefore be authorised to regard these quantities as very nearly equal; and consequently neutralizing each other. The preceding equations (6) and (7) will then become

$$C\,h = \frac{\pi}{3} \qquad (8)$$

for the value of the toll, or clear profit, per passenger, and

$$C'\,h = \frac{\pi}{3} + \delta\,h, \qquad (9)$$

for the gross charge for conveyance.

The rule which should be proposed for computing the tariff, will be drawn from the formulæ as modified by these considerations, and it may be expressed in few words—*add to the constant quantity which experiment dictates for the profit per passenger, the actual cost of his transportation* —to obtain the gross charge to be exacted for his conveyance.

The objection which may be urged against the importance of these equations, on the ground of the uncertainty which must attend any attempt to determine a priori the exact value of the constant quantity which enters them, is without force. It would be idle to expect any solution of the problem which would entirely dispense with the exercise of a discriminating judgment, or deprive experience of its usefulness. The formulæ teach us the law by which the charge must vary as the distance increases—and the only unknown quantity may be accurately determined by one or two judicious trials; without their assistance years of experience and the most accurate observation, will still leave the subject involved in the greatest uncertainty.

It will readily be perceived that, by the principles here advocated, there may sometimes be good policy in making a distinction between the different grades of travellers carried on the road; and in adapting the rates levied upon each grade to its actual ability. But, it is probable that such distinctions would be found productive of inconvenience sufficient in this country, to limit them to two classes—the first consisting of those who regard *cheapness* as more important than the superior comforts and more select society offered in the better class of cars, and the second, of those who are willing to pay something for these considerations. But the principles already announced for the assessment of the charges will be applicable to both these divisions;—they will each be required to pay, besides the actual cost of their conveyance, a certain tax, proportional to their respective ability, to go towards the profit of the company; and though the former part of the charge will vary with the distance, the latter part will be the same, whether the visitor to New York take the line at Baltimore, Richmond or Raleigh. The utility of such discriminations is, however, very doubtful unless made with a full appreciation of all the circumstances.

It need scarcely be said, that in fixing the charges for a long route made up of several distinct interests, an agreement between the companies composing it, to prevent injustice from being done to either, is an assumed condition. The method proposed aims for the maximum *aggregate* net income; the equitable distribution of the proceeds among the companies, will involve no difficulty, for the profits of any one line, derived from individuals who pay their fare over that line only, will, of course, belong exclusively to that company; but the profits obtained from tickets over two or more lines, will be divided among the several companies in proportion to the number of miles of travel on them respectively.

It may also be observed that the application of the system is not to be extended to roads so short that the quantity representing the profits would be such as to justify the establishment of a rival. The actual value of this constant must first be ascertained and applied to the distant travel; and if it amount to a higher sum than it would be deemed advisable to charge on the separate roads, or than their charters would permit them to exact, they would be at liberty to make the needful modifications. The regulations adopted on the lines taken separately, would be independent of those which would be applicable to the common interest.

It is not denied that there are plausible objections to the process which has conducted to the conclusions presented in this paper; and that it may not possess all the accuracy that is sometimes attainable in similar researches. But it does, nevertheless, seem to be the nearest approach to a rigorous solution of which the important, but complicated, problem is really susceptible.

Withal, the simplicity of the result adapts it peculiarly for general use and renders its application exceedingly easy on the longest and most complicated lines. It is offered as an attempt to elucidate a subject which seems not yet to have occupied the attention of the profession, or of railroad companies—but which possess the highest interest, both as a question of profit, affecting the dividends due to the greatest investment of capital ever made for any one object of public improvement; and as a question of political economy, involving the measure of the benefit to be derived from the railroad system.

Wilkinson's Press.—It has long been a desideratum to obtain a rotary printing press; and although several have been invented upon the rotary principle, none has yet succeeded in adaptation to newspaper printing, nor we believe to book printing, other than stereotype. Mr. Wilkinson has devoted much time to this subject. and has at length constructed a machine, which not only overcomes the objections that have prevented the success of other machines, but which appears, in every desirable quality, to be superior to any press in use. In rapidity, accuracy, cheapness, both of construction and of running, it is believed to be unrivalled, and if it works as well as it certainly promises to, we do not see but it will effect a revolution in the art.

This press is capable, with less than one horse power, of throwing off twenty thousand impression an hour, printed on both sides. The types are set with the same facility as those in common use, and the contrivances for taking the proofs, placing the matter on the cylinders on the press, are such that all the operations can be performed as rapidly and as easily as with the ordinary types and presses. One boy can attend the machine with perfect ease. The machine is about six feet long, four feet high, and of any required width; it can be made, we should judge, for about a thousand dollars.

Notwithstanding the almost incredible power of this press, it is simpler in its construction than any power press in use; and herein is its great beauty. There are less than twenty wheels to drive the whole, and but *one* stud (or unnecessary wheel, employed to connect the parts, without driving any thing itself.) This does not belong to the machine proper, but connects it with the shears which cut the sheets off; for the paper is not cut into sheets previous to being printed, but is placed upon the machine in rolls. The shears cut it not quite in two, leaving sufficient tenacity for it to roll up, but dividing it so far that it will easily separate by a slight jerk. A register is attached which, counts the sheets as they come off.

The impression is as good as can be obtained on any press, and the types are less liable to wear, or rather they wear uniformly, not battering the edges. The machine now in operation will print three columns of the width of the Journal, and four inches longer. The types are of a peculiar construction, but can be cast as cheap as those ordinarily used. The composing sticks and other materials are also of a different construction, but not more costly. The machine, being so simple, it is not liable to get out of order, and not expensive to repair when it does.

So completely had the inventor planned the whole that the machine was built precisely according to the first draft, and required no alteration, but performed on the first trial equal to the expectations that had been formed of it. It may be called a perfect machine, and we can see nothing to prevent it from going into general use.—***Providence Journal.***

Black Paint.—A paper recently read before the London society of arts, of which extracts are given in the English papers, contains some information that will be interesting to ship owners and others. The author

Mr. L. Thompson, states that black paint is in general very injurious to the wood on which it is laid. He says that any one who will observe a ship that has been for some time in a tropical climate will see the proof. "it will be found that the wood round the fastenings is in a state of decay while the white work is as sound as ever; the planks that are painted black will be found split in all directions, while the frequent necessity of caulking a ship in that situation likewise adds to the common destruction; and I am fully persuaded that a piece of wood painted white will be preserved from perishing as long again if exposed to the weather, as a similar piece painted black, especially in a tropical climate." He adds:

"I have heard many men of considerable experience say, that black is good for nothing on wood, as it possesses no body to exclude the weather. This is indeed partly the case; but a far greater evil than this attends the use of black paint, which ought entirely to exclude its use on any work out of doors, viz: its property of absorbing heat. * * Wood having a black surface will imbibe a considerable more heat in the same temperature of climate, than if that surface was white; from which circumstance we may easily conclude that pores of wood of any nature will have a tendency to expand and rond in all directions, when exposed under such circumstances. The water, of course, being admitted, causes a gradual progressive decay, which must be imperceptibly increasing from every change of weather."

Two circumstances that had fallen under the writer's observation, are given in proof of this:

"The first was the state of H. M. sloop Ringdove, condemned by survey at Halifax, N. S. in the year 1828. This brig has been on the West India station for many years. On her being found defective and a survey called, the report was to the effect that the wood round all the fastenings was totally decayed in the wake of the black, while that in the wake of the white was as sound as ever. The next instance relates to H. M. ship Excellent, of 98 guns, (formerly the Boyne.) The ship is moored east and west, by bow and stearn moorings, consequently th estarboard side is always opposed to the effects of the sun, both in summer and winter. In this situation her sides were painted in the usual manner of a ship of war, viz: black and white, of which by far the greater part is black; this latter portion on the starboard side I found it impossible to keep tight; for, as often as one leak was apparently stopped, another broke out, and thus baffled the skill of all interested.

In the mean time, the side not exposed to the rays of the sun remained perfectly sound. I then suggested to Mr. Kennaway, the master caulker of H. M. dockyard at Portsmouth who had previously given the subject consideration, the advan tages likely to be derived from altering the color of the ship's side from black to white. Captain Hasting approved of the alteration, the ship was painted a light drab color where it was black before, upon which the leaks ceased, and she now has continued perfectly tight for more than twelve months; and indeed, I can confidently state, that the ship will last as long again in her present situation, as she had begun to shrink and split to an astonishing extent when the outside surface was black, which has entirely ceased since the color has been altered."—*New York Post.*

Wrought Iron Shafts.—One of the greatest improvements in steam navigation is the introduction of the wrought iron shaft, which is now generally, if not altogether, used in Great Britain. Of the multitude of boats running in the waters of the United States, we know of only one that has a wrought iron shaft, and that one is the floating palace called the Burlington, Capt. Sherman's boat, on lake Champlain. This shaft was imported from Scotland. It is with us an almost every day occurrence to hear of the breaking of the shaft of some steamboat, and when this is the case it is generally followed by the breaking of other parts of the machinery, to the amount, frequently, of some thousands of dollars, and the detention of the boat. Under these circumstances, we rejoice to learn that the leading proprietors of steamboats in Canada have determined to introduce the wrought iron shafts; and we understand that the only reason why they have not been brought into use in this country was the want of machinery to make them. That difficulty no longer exists. Yesterday we accepted an invitation to visit the iron works of Mr. L. B. Ward, at the foot of 59th street, on the North river. Here we spent some time in seeing the process of manufacturing a shaft, which is twenty-three feet five inches long, and in the manufacturing of which six thousand pounds of iron have been used. The shaft will be finished in the course of the night, and will then weigh upwards of four thousand pounds. The material used is the best American iron, and in welding every care has been taken to make the shaft complete and perfect. We are told that steamboat machinery, equal to any in the favorite Britannic ships, can now be made in this city—perhaps at a little more expense than in England or Scotland, but it can be done, and well. Machinery is now making in New York for Russia and Spain. The trip hammer which we saw at work on the shaft, at Mr. Ward's, weighs thirteen thousand pounds, and is worked by a steam engine of thirty horse power. The shaft is not suffered to cool from Monday morning until Saturday night; two sets of workmen are employed, who relieve each other at suitable intervals.—*New York American.*

American Mechanics.—It is stated that a company in Trieste, Austria, have despatched an agent to buy the entire machinery of a flouring mill, and to take it over to Trieste. Some shipments of wheat having been made to the United States from Austria in 1836, '37, it was ascertained by those who sent it, that when it was ground up in this country, better flour and more in quantity was produced than could be obtained from the same quantity of wheat in Austria. The knowledge of this fact caused the mission of a special agent for the purpose above named. A New York paper says—.

The agent on his arrival in New York, contracted with the Lafayette Burr Stone company, at the corner of Robinson and Washington streets, to construct 8 run of mill-stones, of a sufficient size to turn out 500 barrels of flour per day. These 16 stones are now completed, and heve been shipped. The running gear and the working gear have all been made in this city, and the whole will cost about $15,000. A miller from Richmond has also been engaged to go out to Austria, and work the mill three years. A millwright also goes out to put up the mill. In short, this country furnishes every thing connected with it except the frame of the mill.

This movement is but the first of a series towards an extensive business to be done by the United States in the manufacture of mills and machinery for European nations. Already has this country sent out to France, England, Russia, Turkey, Austria and other European countries, frigates, steam-ships, sailing vessels of all kinds, locomotives, steam engines, cotton gins, printing presses, mill machines, and all kinds of improvements in every description of machinery; and Mr. Cochran has supplied the Pacha of Egypt with guns to carry on the war against the allied powers. We have steam frigates on the stocks for Spain, one for Russia, in our waters, printing presses for the continent of Europe, just finishing at Hoe's foundry; many chambered cannon just finished for the Pacha by Cochran; rifles and guns of all kinds on the way to France; American cotton gins just finished, and put up by an American in Manchester; and in fact all sorts of machinery making, and to be made, for the old world, by the enterprising, industrious and ingenious artisans of the new world.

A Safety Beacon has been erected on the Goodwin Sands, by which it is hoped to avert the dreadful loss of life by shipwreck, so often occurring at that dangerous part of the British channel. It is thus described:

It consists of a column about forty feet above the level of the sea, having cleets and ropes attached to four of its sides, with holds for hands and feet. At the summit of the column is attached a gallery of hexagon form, made of trellis work, and capable of holding twenty persons at one time. Above the gallery, and in continuation of the column, is a flag-staff ten feet long, thus making the entire beacon fifty feet in height. The sides of the gallery are so constructed as to enable the persons in it to be covered in with sailcloth, which is reefed in and around it, and can be used at pleasure, as also an awning to pass over it which is fixed to the flag-staff, thus entirely protecting any unfortunate marriner who may seek shelter on the column from foul and tempestuous weather. A barrel of fresh water, together with a painted bag enclosing a flag of distress, is stationed on the gallery, and the words "hoist the flag," painted, in the languages of all nations, on boards stationed round the inner part of the gallery, so that the foreigner as well as the native seamen may be enabled to show a signal of distress, and obtain help from shore, which is about seven miles from the beacon.

American Copper.—We are gratified to learn from a late number of the Wisconsin Enquirer, that Messrs. W. Alvord and P. W. Thomas of New Baltimore in that territory, have met with complete success in their experiments on smelting copper ore. They constructed a very simple furnace which cost ten dollars, in which they smelted on the 28th of September last, 2,500 pounds of ore, from which they obtained nearly 700 pounds of good pig copper, pronounced, by competent judges, to be superior to the South American pig copper. The time occupied in procuring from the ore the above amount of copper, was only nine hours. Neither Mr. Alford nor Mr. Thomas had had any experience in the business of smelting, and the result is justly deemed a matter of great consequence to that Territory, which abounds in rich copper ore.

We import over three millions worth of copper annually, which we hope ere long to obtain from our own mines, while we export largely this valuable metal.

Collinsville Axe Manufactory.—These works, for extent and complete workmanship, have not a parallel in the States, nor in the world. The number of axes and hatchets manufactured when the works are in full operation, are about eight hundred daily. All the axes undergo the most rigid inspection and every one bears the stamp of "Collins & Co." In the excellency of the stock and complete finish, they have no where a superior.

The most curios part of the works is the press. This gigantic piece of machinery receives the heated iron from the bar, and with a few motions of its huge jaws, in the space of one minute, throws out the axe complete, except steeling. It is then passed to the hands of the forger, still glowing with heat, to receive the steel.

The welding in of the steel is very speedily performed, and made ready for the grinder.

The principal forging-shop has twelve circular chimn[illegible]ys with 4 fires to each. All these fires, together with the temperers' fires, and several others connected with the establishment are supplied with wind from a single bellows. This is very large and powerful; it occupies together with a large water wheel and machinery, an entire building. The wind is conveyed from the bellows in different directions, through large iron pipes under the ground, to the several shops and thence through smaller ones to the forges.

Any person wishing a quantity of axes of any particular pattern, can have them in one hour after the order; they will have passed through 12 classes of hands to be ready for delivery.—*Springfield Republican.*

Polytechnic Institution.—Two models of inventions, connected with the all absorbing subject of travelling by steam on land and water, have recently been deposited at the Polytechnic institution, in Regent street. One of these is a plan, devised by Dr. Spurgin, for preventing engines and carriages running off the rails, the greatest danger to which railway locomotion is exposed. The alteration proposed by the inventor appears to be at once simple, effective, and practicable. By elevating the line of a rail a sufficient height above the ground, room will be gained to permit a large portion of the body of the engine or carriage to go below the wheels on which they travel, being affixed to their sides instead of underneath. By this arrangement the centre of gravity will be much nearer the rail than it is at present, and a greater portion of the danger of top-heavy impetus be avoided, as it will be almost a physical impossibility for a train thus built to get off the rails. This improvement ought to be looked to immediately, as if effectual, it is certainly practicable. The other model exhibits a scientific alteration in the common paddle wheel of a steamboat, and, assuming that inventive genius should direct its energies towards the improvement of this always objectionable means of propulsion, instead of assisting to discover a new perfect method, we should say that great credit is due to the inventor, Mr. Stevens, of Woodford. His plan is this:—Every float is the segment of a sector, and each coincides with the other; in fact, it is like nothing so much as a common ventilator in a window frame or door. The inventor states that its construction is founded strictly on theory, and that it possesses the greatest propelling effect, without any backwater or vibratory motion. The institution closes for six weeks on Saturday, in order to allow time for considerable additions and improvements.

The Thames Tunnel.—The famous Thames tnnnel, as is well known, is now near completion. The mode of egress, for foot passengers, is to be by a spiral staircase. The carriage way is to be spiral, and two hundred feet in diameter. The gradients of the road will be about one foot in twenty-five, forming an inclination by no means inconveniently steep.

The railroad between Boston and Salem has conveyed a million of persons in the year it has been open, without injury to a single traveller.

Another Iron Steamboat.—The Louisville Gazette notices the construction of an iron steamboat in that city, which was launched a few weeks since. The experiment made by the projectors of the Valley Forge has been entirely successful. Its bottom is nearly, if not quite, proof against snags, and escapes injury from bars and shallows altogether. Success attend this new enterprise.

Apropos.—The Britania has taken to Havre, from London, an iron steamboat in five hundred and seventy-two pieces. This vessel, which is intended for the Lake of Geneva, will be one hundred and thirty-three feet long, and the materials are to be transported thither forthwith.

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 2, Vol. VI. New Series. | JANUARY 15, 1841. | Whole No. 374. Vol. XII.

LAWS OF TRADE — RAILROAD FARES.

Our readers will perceive that the last number contains the fifth and concluding essay on this subject, by our esteemed friend and correspondent, *Charles Ellet, Jr.*, C. E. We have more than once offered our testimony to the service Mr. Ellet has rendered the profession and the public generally, in reducing the investigation of this all important topic, to strict mathematical language, thereby placing his demonstration, beyond the reach of doubt.

Since we last noticed this subject we have had additional opportunities of ascertaining the necessity of correct principles for the establishment of railroad tariffs, and the lamentable effects resulting from a want of such principles. We were not aware that so much ignorance actually existed on the part of those most concerned—the stockholders and directors of railroads. It is sufficient to say that we have heard the doctrine boldly announced that the directors of a road are not bound to afford any accommodations or inducements to increase the traffic of a road, and that they have the right to run their trains often or not at all, just as may suit their own views.

Of this we have more to say hereafter; what we intend at present, is to propose to Mr. Ellet, the subject for a supplementary essay to those already published, viz., the investigation of the loss sustained by the working a road beneath its capacity—either by not running a sufficient number of trains or by running trains not filled, when a slight decrease in fare would fill them. We would further suggest the introduction of another element, the increased traffic caused by an increase in the accommodations of a road, particularly in the vicinity of large cities. It is well known that in such cases the number of persons making a permanent residence near a city, is in direct proportion to the inducements offered, and that the expression for the increase of business on such a road, must include as an element, the increase of population at one of the termini. We are aware that this subject is incidentally mentioned in the papers of Mr. Ellet, but we propose the topic for more extended consideration in a future number.

NEW FORM OF RAIL.

We acknowledge with pleasure the receipt of a pamphlet, from *Benjamin H. Latrobe, Esq.*, C. E., containing a description of a now form of rail, to be called the Z rail.

The name of this gentleman, is at once sufficient to demand for his improvement the consideration it deserves, and to distinguish it from that class of inventions which is characterized rather by ingenuity and curiosity, than by practicability and simplicity. Our readers are aware that Mr. Latrobe has been employed to examine the various modes of construction now in use, and that from his own experience he is well qualified to propose improvements in this most important part of railroads. In a future number we hope to be able to give an outline, at least, of the peculiarities and advantages of the Z rail.

For the American Railroad Journal and Mechanics' Magazine.

ON THE TRUE THEORY OF CRANK MOTION. By *W. Mc Clelland Cushman*, Civil Engineer.

(Continned from page 7.)

Recurring now to our general equation of equilibrium

$$\int dz \cos \mathrm{B\,P}' = zp'$$

let the foregoing values of B and P′ be substituted instead of them in that equation, and values expressed in terms of z and data replaced sine A and cos A ($= \sqrt{1 - \text{sine A}}$) ; it will then have taken an integrable form. We have, however, yet to observe of that term requiring integration by sines, that in actual cases the difference in length between l and r will never be less than 2 to 5. Accordingly performing the evolution, we get

$$\text{sine}\, z . \frac{l}{2\,r} - \text{sine}^3\, z \frac{l^3}{16\,r^3} - \text{sine}^5\, z \frac{l^5}{256\,r^5} \text{ etc.}$$

in which it is therefore clear that all terms except the first may be disregarded for all purposes not entirely speculative. This amounts to taking cos A = 1, in the term in which it does not rise above the first power, which again may clearly be done without injury to the practical accuracy of the result, since from the smallness of the angle A even when the position of the crank gives it its greatest value, its cosine cannot differ materially from 1, and the difference is of course in other positions still less worthy of consideration. Observing these points, we obtain the following expressions of the *amount* of moment communicable to the crank while running over the respective arcs, D M, M D′, etc.

$$\left.\begin{array}{l} 1^{o},\ +\ P.\int dz\left((\text{sine } z - \text{sine}^2 z \frac{l^2}{4r^2} + \text{sine } z \cos z \frac{l}{2r}) \cos m + \text{sine } m (\cos z - \text{sine}^2 z \cos z \frac{l^2}{4r^2} - \text{sine}^2 z \frac{l}{2r})\right) \\ 2^{o},\ -\ P.\int dz\left((\text{sine } z - \text{sine}^2 z \frac{l^2}{4r^2} + \text{sine } z \cos z \frac{l}{2r}) \cos m + \text{sine } m (\cos z - \text{sine}^2 z \cos z \frac{l^2}{4r^2} - \text{sine}^2 z \frac{l}{2r})\right) \\ 3^{o},\ -\ P.\int dz\left((\text{sine } z - \text{sine}^2 z \frac{l^2}{4r^2} + \text{sine } z \cos z \frac{l}{2r}) \cos m + \text{sine } m (-\cos z + \text{sine}^2 z \cos z \frac{l^2}{4r^2} + \text{sine}^2 z \frac{l}{2r})\right) \\ 4^{o},\ +\ P.\int dz\left((\text{sine } z - \text{sine}^2 z \frac{l^2}{4r^2} + \text{sine } z \cos z \frac{l}{2r}) \cos m + \sin m (-\cos z + \sin^2 z \cos z \frac{l^2}{4r^2} - \sin^2 z \frac{l}{2r})\right) \end{array}\right\} = M$$

It is not however absolutely requisite to operate separately upon each fraction; for as the 1° and 4° are precisely alike except in respect to engines which affect two terms of each, and have precisely similar limits, it will amount to the same thing to add them together, cancelling like terms, having contrary signs, before actually performing the integration; and so of the 2° and 3°.

Reducing accordingly, we get

$$\left.\begin{array}{l} +\ 2\ P.\int dz\left((\sin z - \sin^2 z \frac{l}{4r^2} + \sin z \cos z \frac{l}{2r}) \cos m - \sin m \sin^2 z \frac{l}{2r}\right) \\ -\ 2\ P.\int dz\left(\sin z - \sin^2 z \frac{l^2}{4r^2} + \cos z \cos z \frac{l}{2r}\right) \cos m. \end{array}\right\} = M$$

and then integrating each between its respective limits, viz: $z = o$ and $z =$ D M or D M′ for the first and $z =$ D M or D M′ and $2 = 180^{o}$, for the second,

$$\left.\begin{array}{l} +\ 2\ P.\left(-\cos z + (\frac{\sin 2z}{4} - \frac{z}{2}) \frac{l^2}{4r^2} + \sin^2 z \frac{l}{4r} - (\frac{\cos 2z}{4} + \frac{z^2}{2}) \frac{l}{8r} + 1 \cdot + \frac{l}{32r}\right) \\ +\ 2\ P \left(\cos z - (\frac{\sin 2z}{4} - \frac{z}{2}) \frac{l^2}{4r^2} - \sin^2 z^2 \frac{l}{4r} + 1 - \pi \frac{l^2}{4r^2}\right) \end{array}\right\} = M$$

wherefore, finally, after reduction to its simplest state, will

$$4\ P - P\left(\cdot (z^2 - \sin^2 z) \cdot \frac{l}{8r} + \frac{\pi . l^2}{2r^2} \cdot \right) = M.$$

such is the total amount of moment communicable to the end of the crank, in the direction of its motion, during a complete revolution. And as the actual moment of the power during a revolution, or double stroke of the pistons, is expressed by 2×2 P when radius $= 1$, we perceive that an amount of moment expresed by

$$P \left[(z^2 - \text{sine}^2\ z) \frac{l}{8r} + \pi \frac{l^2}{2r^2} \cdot \right]$$

must always be lost, in conveying the power for the piston to that point.

As previously shown, the actual moment compared with the moment of the power expended, determines the proportion of effect produced, etc., that is

$$\frac{M}{4P} = 1 - \tfrac{1}{4} \left[\cdot (z^2 - \sin^2 z) \frac{l}{8r} + \frac{\pi l^2}{2r^2} \cdot \right]$$

will always designate the proportion of the power actually effective upon the end of a crank, in the direction of its motion.

So also the actual amount of moment lost compared with the moment of the power expended, viz.

$$\frac{4P - M}{4P} = \tfrac{1}{4} \left[\cdot (z^2 - \text{sine}^2\ z) \frac{l}{8r} + \frac{\pi l^2}{2r^2} \right]$$

will always designate the proportion of the power lost, or expended entirely without effect.

Translating this result into words, we perceive then, that $\frac{1}{16}$th of the difference of the squares of the arc and sine of the arc, of the maximum into the ratio of the throw of the crank to length of connecting rod, plus half the square of the same ratio into the arc of the quadrant, will always give the true proportions of power lost in conveying it from the pistons to the end of the crank.

That the particular origin of the deficit of moment which has been shown to exist, is as was previously asserted, is now easily made apparent. For, taking the expression of that deficit, it is clear that, as the length of connecting rod is increased, the loss of moment will diminish in amount; and finally when the length is supposed to be indefinitely great, we must have

$$4P - P \left[(z^2 - \text{sine}^2\ z) \cdot 0 + \frac{\pi}{2} \cdot 0 \right] = M$$

and consequently $\quad 4P = M$

showing that, in that case, the amount of moment communicated would be just equal to the moment of the power expended. Now as the supposition which has been made with reference to length of connecting rod amounts to nothing more than supposing the power to act directly upon the end of the crank *in directions constantly parallel* (*Note* 2,) we perceive that the *deficit* of moment and *corresponding loss of power* is entirely attributable to the *obliquity of the connecting rod* with reference to the fixed direction of the power.

To make application of the formula which has been established, let l be supposed $= 16$ inches, and $r = 40$ inches. Then since sine A $= \cos z$ when the crank is at the position of the maximum, and sine $z \frac{1}{2} l =$ sine A r universally, we have

$$\frac{\text{sine } z}{\cos z} = \frac{2\,r}{2} = \text{ton } z = \frac{80}{16} = 5.$$

for the tangent of the angle of the maximum, which accordingly proves to be $78^{\circ}\ 41\frac{1}{2}'$; also

$$z = \frac{78^{\circ} \cdot \cdot 41\frac{1}{2}'}{180^{\circ}} \times 3 \cdot 1416 = 1 \cdot 3734; \text{ and } \frac{l}{r} = \frac{16}{40} = \cdot 4$$

Hence $$\frac{4\,P - M}{4\,P} = \tfrac{1}{4}\,(\cdot 0464 + \cdot 1256) = \cdot 043 \qquad (1.)$$

Showing that in engines of such dimensions very nearly $4\frac{1}{3}$ per cent of their powers is expended without effect upon the crank.

I have previously established, experimentally, the total loss from the crank in practice, for engines of precisely these dimensions, at ·0583 P. So that about $\frac{3}{4}$ of the total loss of power, *is entirely independant of friction of parts;* and is ascribable, exclusively, to the influence of the first of the two general causes of loss of effect named in setting out.

With regard to the resistance of friction opposing the motion at rubbing points, the second of the two general causes of the reduction of effect in crank motions:—the whole quantity of power abstracted by friction is made up of the following distinct items, viz.

1°. Friction in the guides of the head of the piston rod, caused by the reaction of the force communicated to the connecting rod upon those guides.

2°. Friction at the points of the connecting rod.

3°. That taking place within the cylinder, and made up of the attrition of the piston in the cylinder, and of the slide valves, which regulate the circulation of steam.

As to the amount of force abstracted by the reaction of the power in the guides:—Let $\frac{1}{m}$ represent the ratio of friction to pressure between lubricated sufaces of iron: then as the degree of direct pressure, at right angles to the guides, at any point of the stroke is expressed by P′ sine A we must have $\frac{P' \text{ sine } A}{m}$ for the corresponding proportion of friction; or replacing P′ by its value P cos A, and putting a for the mean resistance we must have for the total moment of resistance

$$\int d\left(\tfrac{1}{2}l\cdot\overline{1-\cos z}\right)\cdot\frac{P\text{ sine }A\cos A}{m}$$

and consequently,

$$\int d\left(\tfrac{1}{2}l\cdot\overline{1\cos z}\right)\frac{P\text{ sine }A\cos A}{m}=\tfrac{1}{2}l(1-\cos z)\,a$$

writing now cos A = 1, for the same reason as before; and limiting the integration between $z = o$ and $z = 90^{\circ}$, because A is a maximum at the middle of the stroke and our equation would in consequence give equal results upon either side; we obtain, on taking the integral

$$a=\frac{P}{m}\cdot\frac{l2}{8r^2}$$

cos, as the value of m for such surfaces in machinery, is settled experimentally at 24, we may write, in general, for the mean resistance from friction caused by the reaction of the power in the guides of the piston head

$$a=\frac{P\,l^2}{192\,r^2}$$

Hence when $l = 16$ and $r = 40$ we have

$$a=\frac{.16}{192}P=\cdot0008\,P \qquad (2)$$

2. With reference to the friction at the points of the connecting rod:—Its direct influence at those points being necessarily diminished in the ratio of the radii of those points to the length of the connecting rod, we should have, putting d for the mean diameter of the points.

$$a'=\frac{P\,d}{m\,r}=\frac{P\,d}{24\,r}$$

for the general value of this item; accordingly when $d = 3$ in. and 2 and r as before, we have $a' = \cdot\ 0030$ P (3)

3. The slide valves (shown at $x\,x$ in the figure) worked alternately to and from by the eccentric, keep up at all times communication with the boiler and one side of the piston, and with the atmosphere and the other side; and being kept to their seat by the pressure of steam, must subtract from the power a quantity proportionate to their area, in virtue of friction between the surfaces sliding in contact.

If then v = area of the slides; δ = diameter of the pistons; s = range of the slide; u the pressure of steam per unit of surface; and $\frac{1}{m'}$ = the proportion of friction to pressure of the surfaces in contact; then as the slides accompany the motion of the piston, we shall have $\frac{u\,v}{m}\cdot s$ for the moment of the resistance of the slides, and

$u\,\delta^2\,\frac{\pi}{2}\cdot l$ for the moment of the pressure of steam upon the pistons, each during equal intervals, to wit, the stroke of the piston. The ratio of these two quantities will accordingly give the proportion of resistance to power expended. We have accordingly

$$a''=\frac{\frac{u\,v}{m'}.s}{u\,\delta^2\,\frac{\pi}{2}.l}=\frac{2\,v\,s}{m'\,\delta^2\,\pi l}$$

for the general value of the resistance from friction of the slide valves. And the friction of ground and polished surfaces of iron being $\frac{1}{10}$ the pressure when $v=39$ in. effective surface, $\delta^2=125$, and $s=3$ inches, as in the case of the engines which furnished the value of the total loss, we have consequently

$$a''=\frac{2\times39\times3}{10\times196\times16}=\cdot0072 \qquad (4)$$

As to the remaining item, the resistance to the motion of the piston from friction at the periphery of contact of its disc against the interior of the cylinder, it is necessarily a constant quantity from the construction of the discs; and bearing consequently no relation to the pressure of steam, it is impracticable to express it *generally*, in terms of P. But the working pressure and the absolute amount of resistance, being in the case of these engines known, its amount in the particular instance of such engines, may be easily established. For the total resistance of an engine without any load, minus the friction of its wheels, will be nearly the value of the absolute resistance from friction of the piston; because the slide valves being kept to their seats by the pressure of steam upon them, cannot present any sensible resistance in such case; and the friction of the pivots, etc., when unloaded, is also inconsiderable.

Now the resistance of those engines unloaded exclusive of that of their wheels amount on the average to about 50 lbs., and their working pressure of steam, is about 60 lbs. per square inch, (effective.) We have consequently

$$50 : 60\times196 :: a'''=\frac{50}{60\times196}=\cdot0041 \qquad (5)$$

for the proportion of power abstracted on account of resistance from friction at the periphery of contact of the pistons of the engines in question.

Such, consequently, are the results of accurate estimation, a priori, of the respective items of power lost in virtue of each of the two general causes which always limit the effect producible upon the crank by a given expenditure of power: and these results when aggregated, ought to agree with the total loss obtained directly, from experiment upon the engines themselves.

Recapitulating accordingly all foregoing results for this purpose, we obtain from

Equa.	(1,)	the loss	[direct]	from deficit of momentum, etc.,	·0430
"	(2,)	"	[indirect]	from friction caused by reaction in the guides, etc.,	·0008
"	(3,)	"	"	at points of connecting rod,	·0030
"	(4,)	"	"	of slide valves,	·0072
"	(5,)	"	"	of the discs of the pistons,	·0041
				Total amount of power lost,	·0581 P

Showing that in locomotive engines of the foregoing dimensions, we ought, from *due estimation* of the influence of the two causes inseparable from the action of the crank, to *expect*, on actual trial, to encounter a loss of power of ·0581 P.

The total amount of loss, *by experiment*, in the case of engines of precisely these dimensions, as stated in the note previously referred to is accurately

$$\frac{1}{8}\times\frac{15-8}{15}=\cdot0583\text{ P};$$

or rather of P reduced to the fulcrum of the motion at the bearing of the impelling wheels upon the rails, which amounts to the same thing; because the wheel and crank being connected together in an invariable manner, no further change can take place in conveying the effect from the end of the crank to the bearing upon the rails, than mere reduction of pressure in proportion to velocity of parts; in which case, as previously shown, the effects produced at each point are perfectly identical and convertible the one with the other.

The harmony of the results we have deduced from principle, with fact as developed by experience, is then most remarkably complete; (*Note* 3,) and nothing more is needed to verify the principle of the formulæ which have been investigated, and establish them as being the proper constituent elements of the true theory of the crank.

Albany Dec., 1840.

NOTE 2. This is the case of *minimum loss*. However, from the nature of things, the connecting rod must always, in actual cases, be of very limited length; and rotation of the crank cannot consequently proceed without the aforementioned *obliquity* of the connecting rod, etc. So that practically speaking, the case of the minimum, in which the loss *would be* zero, is unattainable. It does admit, nevertheless, of a highly important *partial* application to practice which I may hereafter take occasion to elucidate.

NOTE 3. The actual deviation of one of these results from the other is ·0002 P, or 1 part in 5000; *which is less than a half pound Avoirdupoise upon the full propelling power of a locomotive engine;* it would be difficult to point to any department of scientific investigation where laws and principles are so minutely borne out by experience.

For the American Railroad Journal and Mechanics' Magazine.

EXAMINATION OF THE REPORT OF THE CANAL BOARD OF NEW YORK, RESPECTING THE ENLARGEMENT OF THE ERIE CANAL, ETC., MADE APRIL 11, 1840.

The report of the canal board which we propose to examine, discusses at length the project of the Erie canal enlargement, advocates strongly its prosecution, and that of the canal system generally, and endeavors to prove that the resources of the State are adequate for the purpose.

It is consequently devoted, a very considerable portion of it, to an examination of the probable revenue from the canals for the next seven years based upon the rate of increase for years past. Its authors, although influenced by "a rigid determination to be governed only by facts," have, as we think, by the singular manner in which the subject has been treated, arrived at conclusions which are untenable, not warranted by the premises, and from their character, calculated to mislead, and produce great mischief and injustice.

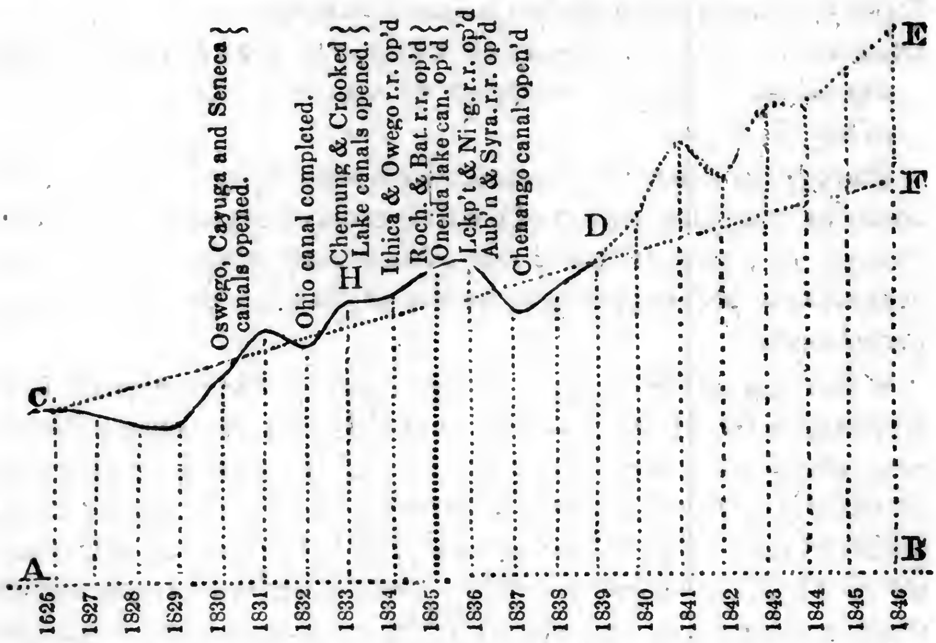
The Erie and Champlain canals, being the *only* canals from which the State has derived a *nett* revenue, were opened for navigation in 1825.

The tolls received annually from these works, after deducting the expenses of collection, are stated in the report as follows:

1826	$839,925,02	1835	$1,395,306,26
1827	849,032,07	1836	1,504,384,05
1828	786,236,64	1837	1,233,648,84
1829	763,527,91	1838	1,365,506,80
1830	990,842,96	1839	1,537,532,92
1831	1,187,139,00*		
1832	1,059,006,36		$16,134,920,30
1833	1,317,258,33	Deduct for 1831	486,350,73
1834	1,305,573,14		
		Total,	$15,648,569,57

For the purpose of exhibiting at one view the annual revenue as above, we have constructed the following diagram in which the line A B is divided into equal parts, corresponding to the different years from 1826 to 1846.

* $486,350,73 added on account of change in fiscal year. See p. 3 of report.



The vertical lines as A C, etc. drawn from these points have their length in proportion to the revenue for each year respectively, and hence the curved line C H D represents the changes or fluctuations of the revenue from 1826 to 1839. The continuation of this line from D to E exhibits the estimated revenue for the next succeeding seven years agreeably to the report.

For the fourteen years ending at D, the whole amount received as above is $15,648,569,57. Making this the sum of an arithmetical series with 14 terms, of which the revenue for 1826 is the first term, the average annual increase is found to be $42,743,07. This gradual increase is represented by the right line C F from which it appears that the revenue for 1839 exceeds the *average* for that year, and of the years intermediate to 1826, *seven* are below the average, and *five* only above. Comparing this average increase continued to 1846 with the estimated revenue as given in the report, and the result is as follows:

Year.	Revenue as estimated in the report.	Revenue on the supposition of a gradual increase.
1840	$1,733,975	$1,438,327,99
1841	2,077,493	1,481,070,05
1842	1,853,261	1,523,814,13
1843	2,305,201	1,566,557,20
1844	2,284,752	1,609,300,27
1845	2,441,786	1,652,043,34
1846	2,632,672	1,694,786,41
Total,	$15,329,140	$10,965,899,39
	10,965,900	
Difference,	$4,363,240	

The total amount received on the supposition of a *gradual* increase at the end of the seven years is *less* than the estimate of the report by $4,363,240,00.

The opinion is expressed in the report, p. 5, that "very great changes in the permanent sources of our trade cannot be well anticipated within seven years." In this we fully concur, and hence are the more surprised at being told, p. 14, that this "Board find *every reason* for believing that the estimate for the next seven years, which they have given, will be *more than realized.* Indeed, it is their *firm belief* that these estimates are *underrated,* and that the *arithmetical* ratio of increase which they have presented is *too narrow,*" etc., etc.

It is, we think, quite obvious from an inspection of the diagram, that the revenue for the next seven years cannot be represented by the curved line D E *unless* "very great changes in the permanent sources of trade," occur within that period.

Although the probability of this is denied in the report, yet very considerable changes seem to be anticipated, viz. in the opening of the Wabash canal, and Blossburgh railroad, the latter of which is to furnish coal for transportation on the canals.

So long as the price of wood at the salt works in Onondaga does not exceed $2,20 to $2,80 per cord, it is not easy to perceive how coal from Blossburg can be used with profit in the manufacture of salt. The coal mines of Blossburgh are as far from Syracuse as those of Carbondale from New York city, and it is not probable that coal in the limited quantities in which it will be at first used, can be afforded at Syracuse for less than $4,50 to $5,00 per ton. Similar remarks will apply to its use for other purposes than that of the manufacture of salt, and hence there is no very great prospect of its being used to that extent on the line of the New York canals for the ensuing seven years, as to make any great difference in the revenue of the canal in that period. There is most certainly no well founded reason for supposing, in the language of the report, p. 11, that the Blossburgh coal "may be brought even to tide water, and compete *successfully* with the foreign article."

The Wabash canal, with its branches extending into Ohio and Indiana, will, when completed, add somewhat to the business and revenue of the Erie canal, but it must not be forgotten that the *gradual* increase in tolls which *we* have assumed *is derived from the ratio of past years,* during which time, the population of the country immediately dependent upon the canals has been increasing in a more rapid ratio than it will probably do for the next seven years, and the *permanent* sources of business have also greatly increased by the construction of important lateral and tributary works, among which may be enumerated, the Oswego, Cayuga and Seneca, Chemung, Crooked Lake, Chenango, and Oneida Lake canals, the Ohio State canal, the Ithaca and Owego, Rochester and Batavia, and Lockport and Niagara Falls railroads, etc., each of which has contributed materially to the tonnage and revenue of the Erie canal. As to the increase in the revenue from the transportation of salt to supply the States and Territories west, no accession from this source greater than has heretofore been experienced can reasonably be anticipated. That the traffic in this article will continue to increase we do not doubt, but not probably in a greater ratio than hitherto. The brine springs of the Kenhawa and Muskingum and also of the Kiskiminitas are now, as we are informed, furnishing brine of much greater strength than formerly, being drawn from a lower salt formation. Those upon the Grand river in Michigan promise to be very productive. These circumstances combined with the very low price of fuel in those sections of the country, may eventually exclude in a great measure the salt of New York from the western market.

The writers of the report seem not to have been impressed with the fact that during the period of the extraordinary advance in prices, through which the country has just passed, a practical *reduction* was at the same time taking place in the tolls, the effect of which was to draw to the canal a greater than ordinary amount of business, and that this stimulus may lose gradually its effect as prices again recede. The canal tolls have no reference to the value, for the time being, of the articles transported, but are regulated solely by the quantity. The toll of a barrel of flour for any given distance is the same, whatever may be its market price. Hence when flour sells at $10, it pays only *one half* the *relative* amount of toll that it does when worth only $5,00, and so of every other commodity. The reduction in prices which is now taking place, consequent upon a return to a sounder condition of the currency, will produce the same practical effect upon the business of the canal that an increase in the tolls would, under a different state of things, that is, it will tend rather to prevent a rapid increase in the business and consequently of the revenue of the canals.

Although we have examined the report with much care, we have discovered no allusion to the circumstance of the two lines of railway, which are constructing from the Hudson to lake Erie, one of which is now completed for two thirds of the distance, and upon which a large amount of freight is destined to be carried, which if it does not diminish the revenue of the canal will prevent its being as great as it otherwise would be. It is true, that at present, most of the railway companies along the line of the canal are compelled to pay tribute to the State for the privilege of carrying freight. This most impolitic and unjust state of things cannot long continue. The line of railway, from its being available at all seasons, and from the rapidity of the transit upon it, will carry merchandize to a very considerable extent, even at higher rates than are charged upon the canal.

Flour and wheat and other products of the country will also find its way to market to some extent upon the railway. What effect this will have upon the revenue of the canal when the disgraceful plan of levying "black mail," to which we have alluded, is discontinued by the State, can be easily anticipated. By recurring to the table p. 50, appended to the report, it will be perceived that the amount of tolls received on merchandize on the Erie canal in 1839 was $524,-387,00. For flour and wheat $363,180,00, both together amounting to two thirds of the whole revenue of the canal. Of these two articles it will be safe to say, that a portion of the flour and wheat, and a large portion of the merchandize, will be conveyed upon the railway, which, with some other lighter and valuable articles will abstract from the tolls of the canal, an amount probably equal to $300,000, or not less than between one-fifth and one-fourth of the whole revenue of the canal.

Much importance appears, in the report, to be attached to the facilities to be afforded by the enlarged canal, in contributing to an increase in the revenue, thus losing sight of the fact, that in all probability, the enlargement, if prosecuted with all available means, cannot be completed within the seven years, and instead therefore of aiding, will serve rather to embarrass the navigation for the whole of that period.

Indeed, we find it stated in the report p. 34, that the work east of Montezuma may be "completed within the next *five* years," and that west of Montezuma "within *two* or *three* years" after completing the enlargement east of that point.

There is not, in any view which can be taken of the subject, any good reason for supposing that the calculations as it respects the prospective revenue of the canals as given in the report, will be realized.

We cannot forbear calling attention particularly to the fact that the words of the report, do not agree with its figures. It is stated,

p. 23, "that the certainty of an increase founded upon a *strict arithmetical proportion* at least corresponding with that which has *uniformly prevailed since the completion of the canals* has been shown to the satisfaction of every reasonable inquirer."

To the correctness of this remark we are ready to respond, but the *calculations* in the report are not in harmony with it. The proportion or ratio of increase, assumed in the report, is not an *arithmetical* one, and varies very materially from that which has "*uniformly* prevailed since the completion of the canal," giving, as we have already shown by the diagram, an aggregate amount of tolls at the end of the seven years annexed in the estimate greater by over *four millions*, than it would be computed in a "*strictly arithmetical proportion.*"

The probable annual expenditure for superintendence and repairs of the canals is estimated in the report at $500,000, and as a reason for the sufficiency of this estimate it is stated, p. 16, that "the improved construction of the enlarged canal will render it less liable to injury, etc," evidently forgeting, that during the whole seven years for which the estimate is made, the enlargement will still be going on, and that the expense for repairs consequent, upon the preservation, of an uninterrupted navigation in the old channel, while the work is being executed will probably be *greater* than it would be under any other circumstances.

The present Erie canal was constructed with stone locks and culverts and with aqueducts, either of stone or supported upon stone piers and abutments. The expense for repairs have been caused *mainly* by ruptures or breaches in the banks and by removal of deposits from the bed of the canal and repairs of the towing paths, rather than by any defects or weakness in the mechanical work. The pressure and volume of water being trebled upon the enlarged canal, casualties of the description first named, will be more likely to occur, producing much greater damage in proportion, and the expenditures for the other items, will also undoubtedly be increased by the enlargement. The "total annual charge on the revenues" is estimated in the report at $1,131,250, p. 15. This sum assumes the "annual average charge for superintendence and repairs" of *all* the *State* canals at $500,000.

Although we believe this to be much less than would be estimated by "a timid capitalist inquiring into the profit and security of a proposed investment," yet we will take the estimate of the board as above, viz: $1,131,250, which for seven years is $7,918,750

The estimated receipts from tolls for seven years, as above, amounts to	10,965,900
	3,047,150
Deduct the principal of the debt redeemable in 1845 and 1846,	2,933,839
Leaving a surplus of only	$113,311

According to the estimate in the report this surplus is 4,476,551 !!

Illusory as the estimate of the report evidently is, yet it is made the basis on which is predicated the ability of the State, p. 23, to pay the interest on an increase of the State debt "of 15 millions at 6 per cent. or 21 millions at 5 per cent. incurred during the next seven years, and *yet to leave large surpluses*" ! ! It is moreover stated that "in addition to all this, causes have been pointed out which *must* produce an augmentation of our canal revenues much beyond the *arithmetical* proportion of former years," or in other words that the anticipated surplus will *positively exceed* the amount above stated of $4,476,551. To this most strange conclusion the board have satisfactorily to themselves arrived by "rigidly confining themselves to a *cold* and *severe* analysis of figures and *to the application of facts that no one can controvert*" ! ! !

Since the presentation of the report, the legislature have authorized loans to the amount of about $4,000,000 00 of which sum $2,500,000 is appropriated to the enlargement. These loans are not payable, it is true, within the next seven years; the interest, however must be met, which at 5½ per cent. is $220,000 00 per annum, or for seven years equal to $1,540,000 00

To pay this there remains only the surplus above	113,311 00
Leaving a balance unprovided for, of	$1,426,689 00

Assuming therefore that no more appropriations are made and debts contracted for the next seven years, and that our estimate of the probable revenue is correct, the tolls remaining unchanged, the State will be compelled, in order to meet *existing* obligations to raise by tax, the sum of $1,427,589 00.

It will not do however, to assume that no more debts will be contracted—the enlargement of the Erie canal is to cost some twenty millions more than has already been expended. The report says, p. 34, that "the completion of the work to Montezuma will cost $10,693,903 00," and that the division west "will require $7,203,040 00 in addition to the work now under contract," the latter "amounting to $1,908,253 00," making in all, for the enlargement alone, full twenty millions. The Genessee valley and Black River canals, will require at least five millions more. The Chemung canal, and enlargement of the Oswego and Cayuga, and Seneca canals will need some four millions, making, in order to carry out the canal system on the plan already commenced, *without regard to the aid to be afforded to railroads,* full thirty millions in all. The most of this large sum will be needed within the seven years embraced in the estimate of the board, the interest accruing on which, prior to the expiration of the seven years, must be added to the amount to be raised by tax as above stated, or otherwise, *new loans must be made lo pay interest.* In the above calculation the interest on loans to railroad companies which the State may be compelled to pay is omitted, as also the interest on debts contracted for the construction of such railroads as may be undertaken by the State within the seven years included in the estimate of the board.

Is it not plain that the board have overlooked in their estimate, considerations of the greatest importance? That if even their own extravagant estimates of revenue should by possibility be realized, it would be wholly inadeqnate to meet the liabilities of the State in the payment of interest alone, the principal of the debts contracted remaining meanwhile, untouched and undiminished?

The evidence that the enlargement of the Erie canal and the construction of the other canals in progress, cannot be prosecuted in the manner recommended by the board, and the necessary aid be given to their works, without resort to new loans, or to taxation to raise large sums to pay interest before the expiration of seven years is so overwhelming, that we cannot imagine how any sober reflecting mind can fail to perceive, or will hesitate to acknowledge its entire conviction of the truth of our remarks.

While the funds of the State are being lavished without measure upon the enlargement of the Erie canal, is it reasonable to suppose, or safe to conclude, that other sections of the State hitherto much less favored, will quietly submit to a sacrifice of their own dearest interests? Will they not rather by a united and firm stand, demand, and *successfully,* that those works in which *they* have an immediate interest and which have the strong claims of utility, necessity and justice to recommend them, should participate in some degree in the bounty of the State?

That such a result is not only probable but *inevitable,* will not, we think be denied. Whatever may be the debt of the State, its faith once plighted, must be redeemed. The fair fame of the Empire State must not be tarnished by any act derogatory to its integrity and honor.

Whenever the period shall arrive in which the resources of the State shall be found inadequate to meet its engagements, what, we will ask, will probably be the answer of the north, the east and the south, to the question which will then be raissd as to the mode of providing for liquidating the debt? Will they not say to the west, and to the canal counties in particular, that since it has been mainly for your benefit that this great debt has been contracted, instead of submitting to taxation we will insist that the tolls be raised upon the canal? In such a state of things it is not difficult to predict, that the west, being most dependent upon the canal will be the greatest sufferers. In their efforts, therefore, to monopolize the revenues of the State, let them beware lest they heap coals of fire upon their own heads to be atoned for hereafter by years of penance.

We would here discontinue our remarks upon the report, but there are some statements so much at variance with the views entertained by us, and withal so inconsistent, that we cannot forbear bestowing upon them a passing notice.

It is well known that very much of the tonnage of the Erie canal is furnished by the lateral, or branch canals, and that in return much passes from the former to the latter. The great expense and delay of trans-shipment between the boats of the different canals, is not noticed in the report; on the contrary, we have the following, p. 42.

"For all commercial purposes the diminution of the cost of transportation on a canal, one half, is equivalent to a reduction of its length one half. In that sense the enlargement of the channel from Albany to Montezuma (at which point, the coal of Pennsylvania sent through the Chemung canal, will be received on the Erie canal,) will operate to reduce the present distance of 206 miles, between these two points to 103 miles; and in the like sense the completion of the enlargement, from Albany to Buffalo, will abridge its total length from 364 to 182 miles; and thus *bring lake Erie with all its growing commerce within half of its present distance from the tide waters of the Hudson*"!!

From this we understand that the Boats on the enlarged Erie canal are to be moved with double the speed at half the present cost, or, that *time* is of no consequence in commercial operations!! We are to understand, also, that notwithstanding the loss and extra expense of trans-shiping coal at Montezuma there is to be a gain for all commercial purposes, in the transportation of this article to market equal to a saving of *half* the distance from Montezuma to the Hudson!!

Among the reasons originally assigned, in favor of the enlargement of the Erie canal, it was stated that it would reduce the cost of transportation 50 per cent. The Board, p. 47, have endorsed and reiterated this statement.

It was undoubtedly upon the truth of this that their conclusions as above quoted, relative to the effect of the enlargement in reducing the distance one half, was made.

Let us see how well the opinions thus advanced, will stand the test of an examination.

The expense of transportation upon the canal is made up of three distinct items.

1st, The tolls, which average upon heavy freights per ton per mile, nearly - - - - - - - -	1 cent
2d, *Cost* of transportation average as above, about - -	1 cent
3d, The profits to the forwarders, not less than - -	$\frac{1}{3}$ cent
Total per ton per mile, - - - - - -	$2\frac{1}{3}$ cents

By recurring to the reports from whence the Board derive their views, it will be seen that the anticipated saving of 50 per cent. applies exclusively to the second of the above items, making the anticipated *saving* per ton per mile for heavy goods on the average about 5 mills or *less than one-fourth* of the whole cost of transportation instead of *one half* as the Board have assumed.

The declaration, therefore, which we have quoted from the report, relative to the reduction in distance is very wide of the truth, and will be still further removed, when it is understood that the saving upon the second item as above, instead of being 50 per cent. will probably not exceed 25 or 30 per cent. at the utmost.

It is worthy of remark, that the canal Board do not enter into the investigation of the subject of the necessity of the enlargement to accommodate the increasing business upon it. The project appears to them to be meritorious principally from its effect in cheapening transportation, but they do not tell us, that the anticipated saving in the cost of transportation consists mainly in the saving in tractile power, which depends upon the ratio of the dimensions of the boat to that of the canal, and which *may be attained to nearly as great a degree of perfection on a small canal as on a large one*, and could have been attained without all this immense expenditure. They do not tell us either, that with half the cost of the enlargement to Buffalo, a navigation might have been opened with lake Erie, via lake Ontario, presenting only half the extent of canal navigation and which would have been the cheapest and most expeditious of all possible navigable routes for the transmission of the western trade.

Before concluding this communication we must advert to a passage in the report, p. 28, where it is stated, that "A more ample supply of water on the western division from lake Erie to the Seneca river, a distance of 149 miles, *is to be secured,* by giving to the level between Lockport and Rochester an increase both of width and declivity, and the channel through the mountain ridge at Lockport, now but 30 feet wide is to be increased to 62 feet with vertical sides." The enlargement of the channel at Lockport is to be extended as we understand, to 90 feet width of surface and 9 feet in depth; being 20 ft. wider and 2 ft. deeper than the average dimensions of the enlarged canal. From Lockport the dimensions will diminish gradually towards Rochester to the size of 70 by 7. East of Rochester it is proposed to construct a large reservoir, to be supplied from the flood waters of the Genessee river. What addition those alterations together with the extra cutting through the mountain ridge at Lockport, will make to the total cost of the enlargement, we leave our readers to judge. It is to be regretted that the reports upon the subject by the Engineer department were not forthcoming at the last session of the legislature. That the expense will be very great, there can be no doubt, and it is incurred for what? "To render it unnecessary, (to use the language of the report) longer to divert the waters of the Genessee river from the mills at Rochester, which has occasioned great injury to the manufacturing interests of that city, and a consequent loss of revenue to the canal"!! And this is the reason why the people of the State are to be taxed some hundreds of thousands of dollars more, to perfect the extravagant project of the enlargement of the Erie canal—viz. that the wheat of the west may be floured at Rochester in preference to being ground at the Little Falls or the Cohoes or at any other of the numerous points where water power is to be found on or near the line of the Erie canal!

From Rochester to Buffalo including the aqueduct across the Genessee river, the enlargement is to cost by the estimate, $6,000,000. The present canal cost $2,000,000, making $8,000,000. Why it may be asked should this small remote portion of the State be thus partaking so largely of the bounty of the legislature, while other important sections are languishing through neglect, and their great and favorite projects, either wholly discarded, or put off with a miserable pittance, in the shape of a loan of the credit of the State, but barely sufficient to prevent them from being abandoned altogether?

It is a matter of deep regret, that the resources of the great State of New York are so injudiciously applied—that its great wealth and strength are, if not wholly wasted, perverted to selfish purposes, and bestowed with little regard to the necessity of the expenditure, or with apparently little consideration as to whether they are expended in a manner to accomplish the greatest possible good.

We are fully convinced that this state of things cannot long continue. The signs of the times, are ominous of an approaching crisis, when the internal improvement system of the State, will be thoroughly anylized, and when, as we trust, such a reform wlll be effected, as will place it beyond the reach of perversion to political or merely selfish purposes.

F.

(Communicated.)

PHILADELPHIA AND POTTSVILLE RAILROAD.

We take pleasure in presenting to our readers the following extract from a notice of this work in a late number of the Pottsville Journal, and are truly glad to learn from other sources the expectation held out of this road being able to aid in delivering coal at tide water in the summer of 1841 will be realized. The coal consumers are paying pretty severely in this season for their fuel, and there is every prospect of a high price in the coming season, unless this additional avenue can be made to aid in the supply.

"This important link in our internal improvements, that is to connect this place (Pottsville) with the emporium of the State, has been rapidly progressing, and will probably be completed and opened sometime in the month of July next.

The bridges and other works have been put up in the most substantial manner, and great attention has been paid to durability and strength. The opening of the road will be the commencement of a new era in the coal business. The long mooted question will then be decided as to which mode of transportation will offer the greatest facilities and most advantageous to the coal operators. One thing is certain, that the railroad company will afford every facility in their power to induce our operators to transport their coal by the railroad in preference to the canal, delivered on the Delaware, where the company have already prepared commodious and extensive wharves for the reception of coal and accommodation of vessels waiting to load.

When we consider the vast amount of coal, merchandize, travelling and produce that will pass over this road, and the durable manner in which it has been constructed, we cannot but think that it will be a source of immense advantage to our region, and of a handsome profit to the stockholders.

Much credit is due to the company for their untiring exertions to bring the road to an early completion, and so far they have been eminently successful. They have continued the work on the road without intermission during a period of the greatest embarrassment in the monetary affairs of the country, and that has never been equalled."

To the Editors of the Railroad Journal and Mechanics' Magazine.

PHILADELPHIA, January 6, 1841.

GENTLEMEN:—I inclose to you a communication which is already published in several of our Gazettes, and which, for the sake of extending its publicity, I would be gratified to see favored by you with a place in your Journal. The facts it states are important; and although they bring to me no conviction I had not before,—to others they may afford stronger evidence than they have before had, and induce an adoption of what may be to their advantage.

PRESERVATION OF WOOD AND CORDAGE.

To divest vegetable matter of its tendency to decay and impart to it prolonged duration, is very generally desirable; and the following additional testimonials in favor of an easy and cheap method of effecting it, which has for some time been before the public, will probably form an interesting article of intelligence to a very large part of the community.

Timber and cordage, from their extensive usefulness, must become principal subjects of its application; but their seems to be no reason why canvass and all cloths and fabrics of vegetable material, when *preservation* is the objeet of attainment, may not share its benefits.

The first of the testimonials referred to, is a certificate given to the patentee by the city commissioners and city carpenter of Philadelphia, to the following effect:

PHILADELPHIA, Dec. 7th, 1840.

"Dr. Edward Earle—Sir—We have examined the condition of that portion of the wooden pavement in Chestnut street, which is between 5th and 6th streets—and that in 6th street, between Chestnut and George streets—and are enabled to make the following representation:

These pavements were laid down, at the same time, in the summer of 1839—about 18 moths ago. They are of blocks of hemlock, 6 inches square by 18 inches long, and perfectly identical as to the kind and quality of timber.

The first—those in Chestnut street—were laid without having undergone any previous treatment to preserve them, and are now so far in a state of decay as to require renewal in many places.

The second—those in sixth street—before being put down, were prepared according to your process for the preservation of timber from decay; and are at this time perfectly firm and sound. We have not been able to discover a single block of them exhibiting the slightest tendency towards decomposition.

A. D. TRAQUAIR, President.
T. K. WALLACE, City commissioner.
ENOCH THORN, City carpenter.

The above pavements were laid by authority of the committee on public highways, for the purpose of testing the effect of this process. The certificate shows the *result*.

The second tesimonial is communicated by the president of the Delaware and Hudson canal and railroad company.

"OFFICE OF THE DEL. AND HUDSON CANAL CO.
New York, Dec. 30, 1840.

Dr. Edward Earle—Dear Sir—I have received a letter from James Archabald, Esq. our chief engineer, in charge of our mines and railroad, and I annex an extract from it: Very truly yours,

JOHN WURTS, President.

Extract of a letter from James Archbald, Esq., dated Dec. 14, 1840.

"I have tested the durability (as far as time permitted) of Dr. Earle's saturated rope; and find it thus far in a perfectly sound condition; and apparently as little affected by rot as a peice put along with it saturated with corrosive sublimate; while rope of the same kind that was not prepared has became completely rotten—and I am thus far perfectly satisfied that the durability of rope will be very much increased by being prepared in the manner that this has been. We are now making experiments which will rot first, the rope saturated with the corrosive sublimate or that saturated with the sulphates. The doctor, however, must recollect that we know nothing relative to what he did with the rope to preserve it, and that before we can judge properly between the merits of his preparation and that of *Kyan*, we must know something about it."

The above has reference to several pieces of rope, (some prepared by my process, the others unprepared) sent by me to Mr. Wurts, and by him to M. Archbald to be subjected to the test of a fungus-pit. Mr. Archbald speaks with prudent reserve of the experiment, as he was not *personally* a witness of the preparation of the rope, and only presumes it, on my authority, to have been prepared with the sulphates of iron and copper. To satisfy his scruples, if really entertained, he has been instructed in a mode of ascertaining the fact, which cannot fail him.

The immediate object of the above experiment has been to ascertain the increased durability that the process by the sulphates of iron and copper is capable of imparting to the ropes used on the *inclined planes* of railroads and whether it would, for such purposes, prove equal to treatment with corrosive sublimate, which has been found effectual.

EDWARD EARLE.

Philadelphia, Jan. 4, 1841.

For the American Railroad Journal and Mechanics' Magazine.

A writer upon arches in the New Edinburgh Encyclopedia remarks that the arch of equilibration is not what it purports to be; but the gross blunders he commits in quoting the demonstration, proves conclusively that he did not understand it; and I will undertake to convict any one who objects to it, of a total ignorance of it. Here then is a challenge to all the world. If you understand the demonstration you will be fully satisfied that it gives you the only arch for strength in any structure, and, on the other hand, if you think it is not so, I will show any one who does not understand the subject that you know nothing about it. Emmerson, Simpson, Hutton, Greggory and a writer in Rees' Encyclopedia, and others, have all examined the demonstration in question, and pronounced it correct, though now and then to some it has proved, I admit, a stumbling block.

To Professors Strong, Gill, and Anderson, who are known to be not second to any mathematicians of the age, I am much indebted for aid in my mathematical researches; and even upon this very subject, and I can therefore speak for them in this case. They will not condemn what they have taken so much gratuitous labor to explain. Who then is it that advises the erection of circular and elliptic arches in the structure of the Croton aqueduct? Every arch that has been there put up requires about one-fourth more weight than it has upon its hances. I have petitioned the common council of our city to take the opinion of some of our eminent mathematicians upon the subject. Give us the names of those who approve of such arches and then we shall know who to meet upon the pages of our public journals. Do the engineers act wholly upon their own responsibility in this case? If so, then I presume they will not hesitate to let us know that they understand what the arch of equilibration is; and when they do so, they may expect that all objections they may have to offer to it will be properly answered.

The public should have the opportunity of looking at both sides of this question. Let it be fairly treated, and my word for it, those who object to the arch in question shall be convicted of a total ignorance of it.

Mathematicians will say that in bringing this subject up as I have done, I have performed my duty; and the common council of our city should exhonerate themselves from all responsibility in this case by putting it where it ought to be—upon our professors of mathematics; and if they, or a majority of those in this vicinity condemn the equilibrated arch they must answer in their characters, to those of all countries who now are or may be hereafter judges of the subject.

It is no answer in this case to say that the circular arch will stand. It accidentally does so in most cases, I admit, but no thanks are due upon that account to the design or the architect; for the pressure falls where no provision is made for it, and the vousoirs or arch stones are entirely useless.

In a word, if Prof. A, B, or C, shall say the circular or elliptic arch is proper in this case, let him take the responsibility and give us his name, so that the common council of our city may be justified in saying to posterity—we have done our duty—we are not presumed to be judges of this subject ourselves, and have therefore left it with those whom this community, recognises to be so; and if they have undertaken here what they do not understand, the fault is not ours.

To conclude, why should not humbug and deception be exposed in this case as well as in any other one. I say, the commissioners and engineers of the Croton aqueduct are listening in regard to the subject before us, to improper counsels; and in this movement, I am supported, as the Croton aqueduct committee of the common council well know, by some of the first characters of this city; and *we*— I say emphatically *we* shall not be satisfied with any thing short of an invitation from that common council for the mathematicians of this vicinity to give their opinion in the premises, and then we shall know whom to meet, and if this cannot be obtained from the present board we shall be very likely to apply to the next one.

OLIVER SMITH.

NEW LOCOMOTIVE ENGINE.—We are indebted to Messrs. Baldwin, Vail & Hufty, for a drawing and description of a new freight engine. The peculiarity consists in connecting the four front wheels with the large drivers. By this arrangement *all* the wheels are converted into drivers, and the whole weight of the engine is used to procure adhesion, while the advantage of the four wheels adapting themselves to the curves of the road is still retained.

It will be seen at once that this form of engine has decided advantages over the ordinary six wheel locomotive, particularly where great adhesion is required in case of heavy freight and severe grades, or short curves.

We have received a communication from our correspondent in St. Louis, in regard to gas works, etc. If possible the information desired will appear in the Journal, but we fear that we cannot comply with this request as punctually as with his last, in regard to wooden pavements.

Our readers will perceive that this, and the last number, are almost entirely made up of original matter. We have omitted our usual extracts from domestic and foreign journals, to make room for the favors of our correspondents, who will please except our best thanks, for their valuable communications.

ENGINEER'S OFFICE WESTERN AND ATLANTIC RAIAROAD, MARIETTA, OCTOBER 15, 1840.

GENTLEMEN—I have the honor to submit a report of operations on the Western and Atlantic railroad, during the 3d quarter of 1840. The accompanying documents will explain in detail, the nature and cost of the work executed.

From the quarterly return herewith submitted, it appears that the work done since the 1st of July, consists of 299,306 cubic yards of excavation and embankment, 3612 perches of masonry in bridges and culverts, 309,975 feet, board measure, of bridge timber delivered, 18 trestle piers framed, and 5 erected, 672 feet of bridging erected, besides 511 feet of superstructure of bridge framed and prepared for raising. The amount paid for which, according to contracts, is $71,597 42. In addition to this expenditure, there appears on the return, as payable on account of repairing finished sections, $4,343 88.

From the abstract of final estimates, it appears that the grading of six sections, and the masonry of two bridges, viz: Etowah and Arms, have been finished during the quarter. The amount of reserved balances paid on their completion has been $18,834.

The total amount expended up to this date, from the commencement of operations, including surveys, location, construction, repairs, the engineer service, and various contingencies, is $1,792,479 50.

The amount that will probably be required to complete the grading, masonry, and bridging of the road, according to existing contracts, is as follows:

For the 1st, 2d and 3d divisions,	$87,040 00
For the 4th division,	42,032 00
For the 5th do. not including the tunnel,	196,304 00
For the tunnel through Little Blue Ridge,	84,303 00
For contingencies on the same,	10,000 00
For the Tennessee division,	170,499 00
Making the total amount required for the above mentioned purposes,	$590,078 00

Many circumstances have contributed to restrain vigorous operations during the last quarter—among these is the terrible sickness which has pervaded the region adjoining the Tennessee line, embracing the principal part of our work in progress.

The amount expended for repairs of sections completed under the contract made prior to December, 1839, is $14,468 48.

When we take into consideration the immense height and depth of many of our embankments and cuts—the unprecedented rains of the last winter and spring falling upon green embankments built during a very dry season, we have cause to congratulate ourselves upon the small expenditure which has been necessary under this head. Moreover, we must consider this expenditure advantageous, as tending to diminish, in a great degree, the cost of keeping up the road after the superstructure shall be laid. Indeed a superstructure of Kyanized timber, laid upon banks consolidated by the settling of years, and carefully repaired by ramming into the breaches choice material, will be so firm and durable, that the cost of repairs, usually a heavy item of expense on a new road, will be quite inconsiderable.

To furnish you with details of information respecting the operations during the last quarter, I extract from the reports of the resident engineers. Mr. Stockton in charge of the 1st, 2d, and part of the 3d division, reports as follows:

"Since the date of my last quarterly report, sections No. 13 and 14 of the second division, and section No. 7 of the 3d division, have been completed and accepted; the masonry of the Etowah and Arms viaducts have also been completed and accepted, and final estimates on each rendered. The masonry of the Vinning viaduct is progressing rapidly, and gives every indication of being well and substantially executed. The foundation of the eastern abutment of the Noonday viaduct has been excavated, and in a few days the contractor for laying the masonry, will commence operations, when the work will be prosecuted with all reasonable despatch. During the past month a small culvert has been introduced on the 11th section of the second division, in order to draw off the large quantity of surface water which collects in the vicinity of that section, after all heavy rains. The masonry and other work connected with the construction of this culvert, was done by the repairing party on that part of the railroad, and charged to repairs. The taring and sanding of the flooring of the Chattahoochee viaduct, has been seriously delayed during the past month, owing to the unfavorable weather which has prevailed. About two thirds of the flooring remains in an unfinished state, but a large force is now actively engaged in its completion. An attempt was made to complete the caulking of the above, prior to covering the same with sand and tar. This plan, however, did not succeed, the action of the sun and rain causing the seams of the floor to open to such an extent, that a recaulking of the same became necessary. A verbal contract for such amounnt of tar as may be required to complete the above, has been made, to be delivered as wanted, and on terms according with the lowest price yet paid for tar on this work.

"All of the repairing parties have been discharged from this part of the road, except two, which are now employed in the vicinity of Allatoona, and on the Franklin embankment. It has been a leading object to restore the heaviest embankments to their proper grade, and by the construction of the proper centre and traverse drains, to place them in a state to withstand the rains, etc. of the ensuing winter. A recent inspection of this part of the road, warrants me in the assertion, that with but a trifling exception on the 14th and 18th sections of the second division, the embankments are in a good state of preservation."

Mr. L. Tilton, temporarily charged with the superintendance of the 4th, and part of the 3d division, reports, that, "Upon the fifth residency a repairing force has been employed for the last month. Its operations have thus far been confined to the 20th section, where, in consequence of the banks having settled much more than could have been anticipated at the time they were made, a large amount of work was required to raise them to the necessary height. Owing to the same cause, considerable labor will be required upon several other sections; but should the weather prove favorable, and an efficient force be employed, the completion of the heaviest portion within the present and ensuing months, may be reasonably anticipated.

"The grading required upon the 25th and 26th sections of the third division, in order to raise the embankments to the requisite height, as indicated by the last spring freshet, has been contracted for by Messrs Keef and Whitesides, and that on the fourth section of the fourth division, by Hitchcock & Co. The masonry upon the latter section remains in nearly the same state as at the beginning of the quarter, the contractor having been obliged to leave the work on account of sickness. It is expected that he will resume operations in a few days, and proceed with the work as rapidly as possible. The framing of the bridge for this section, as well as that part for the 25th section of the third division, is completed, and were the masonry finished, would be raised immediately.

"Towards the completion of the piers and abutments of the Oostanauley bridge, though a return of masonry, etc. appears in the quarterly abstract, nothing has been done except the quarrying of a few perches of rock. In explanation of this return, it may be proper to observe, that a new and accurate calculation of the whole amount of work done, showed that there remained to be returned, the number of perches therein specified, as also the allowance for dressing pier ends and coping, in a manner superior to that called for by the terms of the original contract.

"Upon the masonry of the other parts of the sixth residency, nothing has been done except upon that on the 25th section, which is progressing slowly, and will probably be completed within the present month.

"There now remains unfinished the masonry of eight bridges and arch culverts; in every case, except at the crossing of Swamp Creek on the 19th section, it is more or less advanced.

"The number of sections, the grading of which is unfinished, including three on the fifth residency upon which the grade is to be raised, is eleven; six of which, together with the masonry on the 11th, 17th, and 20th section, have been abandoned within the quater, and statements showing the amount of work done, and that remaining to be done, in each case presented. Favorable proposals for grading the 17th and 20th of the above sections, have been received, but the former has not been let, as it is understood that it has not, as yet, been formally relinquished by the original contractor."

Allan Campbell, Esq., the resident engineer of the fifth division, reports as follow:

"The work generallv has progressed very slowly most of the contractors having been, engaged with small forces. It is unnecessary again to enter into a description of the nature of the excavations on the several sections, as the full account given in my last report, is applicable to the work since done except in a few instances.

"In the deep cut approach at the western extremity of the tunnel, a material of softer nature than that met near the surface, has been found, as the depth of cutting increases, particularly at that portion immediately adjoining the tunnel. Some annoyance has been experienced by the contractor in the prosecution of these excavations, from the appearance of water, arising doubtless from springs having their origin at some higher part of the ridge; and although it percolates through the sides and bottom of the cut in scarcely perceptible streams, yet tends to render somewhat difficult of removal, a material otherwise so very favorable. In a dryer season, it is not improbable that the water here spoken, of would disappear altogether. This approach, (the westren,) is now excavated to a level with the roof of the tunnel, and it requires but little more work to prepar for the commencement of the heading.

"In the eastern approach, the material excavated continues to be only hard. It is, however, favorable for the operation of tunnelling.

"Three sections of the division, viz: the 9th, 11th, and 13th, will probably be completed within the ensuing month.

"I would urge upon your consideration; the importance of providing for the execution of the culvert masonry yet undisposed of. The prices now allowed are not sufficient to induce responsible contractors to undertake it. It is plain that one uniform price, (as at present established,) will not meet the object. What may afford a fair remuneration in one locality, may be entirely inadequate in others.

"While upon the subject of masonry, it may not be improper to remark that the above observations, as to the inadequacy of the prices which have been fixed as the standard on this part of the road, are applicable also to the bridge masonry, but with much greater weight. Abutments which are to sustain the pressure of an immense body of earth, and peirs subject to severe shocks from flood-wood in time of freshets, should be built in the most substantial and permanent manner. To effect this desirable object, sufficent inducements should be held out to responsible men, who will execute the work faithfully, and in accordance with their contracts.

"A large amount of masonry yet remains to be executed on this division. That it will be greatly to the interest of the State to increase the rates of peices fixed for this kind of work, and in proportion to the facilities for procuring stone, lime, sand &c., I am firmly convinced."

Since the date of Mr. Campbell's report, the excavation of the western approach to the tunnel through little Blue Ridge, has discovered at a distance of 200 feet from the entrance to the tunnel, a stratum of blue limestone 10 feet above the grade line lying with such a dip as will pass above the roof of the tunnel near its entrance. Present appearances in the excavation of the approach, lead us to anticipate, that the tunnel will pass almost entirely through rock. The contractor is preparing to lay a temporary track for the removal of the earth from the eastern approach, to form the adjoining embankment. Iron rail, car wheels, spikes, etc., for this purpose, with which the state is bound, by contract, to supply him, are now in course of delivery at the tunnel.

In reference to contracts for masonry, I would wish to impress you with the importance of a good execution of this branch of construction. Economy is of course to be regarded, but not so strictly as to lose sight of the advantages of permanency. The taste which governs the execution of public works in our country, is not so refined as to demand much of the ornamental in our structures. We may therefore discard, this object, and confine ourselves to consideration of durability. This end cannot be attained, without employing good material, and securing the services of good workmen. I do not hesitate to say, that the standard of prices now fixed for bridge masonry, is too low to encourage competent men to undertake and execute faithfully, contracts of this kind. In these matters, excess of liberality is less dangerous than unwise economy.

Before making a decision to adopt the Kyanizing process with the timber for our superstructure, it would be advisable to investigate the claims of Dr. Earle's system of preserving wood. The short time that has elapsed since his discovery of the process, has not afforded a fair experience concerning it. Experiments are now in progress, under the direction of the general government, for testing its efficacy, by exposing timber thus prepared, to artificial causes of decay. The cheapness of the materials used, the sulphates of iron and copper, (the common green and blue vitrol of commerce,) leads us to anticipate that it will be a cheaper mode of preserving wood, than Mr. Kyan's process, in which corrosive sublimate, a costly article, is employed. It certainly would be unwise in us not to avail ourselves of scientific discoveries, applicable to our purposes, and we are admonished by experience, of the great cost of renewals and repairs of wooden superstructures, to adopt some means of diminishing this expense. I would recommend the adoption of some process for preserving the timber seud in our bridges, as well as in the superstructure of our road.

As the time for making some decision respecting our future plans of operation approaches, it is proper to bring to your consideration the necessity of early action with regard to our superstructure. We shall require about 11,000,000 feet board measure of timber, for a single track. The facilities afforded by the neighboring country for furnishing lumber, are so extensive, and to avoid delay, preparation should be made for its delivery sometime before it may be actually needed—moreover, the Byanizing process requires the construction of suitable vats at convenient points along the line of the road. A contract for 11 or 12,000 tons of iron will require a long time for its fulfilment. In view of all these facts, an early consideration of the subject is respectfully suggested.

While on the subject of preparing materials for our superstructure, I would earnestly recommend to you that some engineer officer of our corps be detailed for a mission to England, for the actual purchase of the iron that will be required. The advantages of a thorough inspection of our rails in the course of their manufacture are obvious. Moreover, we shall thus be enabled to avail ourselves of those improvements in details, of plans for depots, ware houses, and in the arrangements for working roads, which have been adopted in the public works of Great Britain. This plan would also saue the usual heavy charges for commissions by the purchasing agents.

Our work has recently been struggling against financial embarrassments. It needs no argument to prove that our present currency will not answer our purposes under existing laws. The bonds of the State paid to the contractors for work done are at a heavy discount. We must look to the next legislature to remove this embarrassment. The present is an important crisis in the affairs of our State. When, in 1836, Georgia awoke from her inglorious lethargy, and issued her fiat, "there shall be a railroad communication to the valley of the Mississippi," the friends of internal improvement, the friends of our country, warmly anticipated the glorious results of energetic action. Were 50,000 square miles of territory to be selected from the map of the United States, as combining the great advantages of position with the elements of prosperity, the boundaries of the selection would nearly coincide with the boundaries of Georgia. Occupying a salient angle of the continent with her fine navigable streams affording easy access to the Atlantic on one side, and the Gulf on the other—a main tributary of the mighty Mississippi almost touching her northern border—an easy passage through her territory to avoid the dangerous circuit of Florida, in connecting the maratime transit from the east with the whole coast of the gulf of Mexico—a connection with the great west incomparably easier than is afforded by the territory of any other State—rich in resources richer in prospect—why should Georgia halt or hesitate in her onward march to her proper station. We have reached the threshold of success and their should be no faltering. The alternative is presented to us of a retrogade movement to our old position of supine insignificance, or the fruition of our high hopes of the prosperity of our country.

I have the honor to be, very respectfully, Your obedient servant.

Jas. S. Williams, Chief Engineer.

Creation of Freight, by Low Rates.—[From the 6th report to the British Parliament.] Answer to Question No. 3843. I consider the present rates on railroads excessive. Even 30s a ton, for the conveyance of our glass, is double what it ought to be.

Question No. 2844. Do you state that with reference to the charges on yourselves, or the excessive profit the railway company is making by the charges? Answer: I do not think they are making a profit by it. I think it is a mistake. I think they would receive a much greater amount by charging a much lower tonnage, than they do at present. I conceive that it will be found and that all experience will prove, that there would be an enormous increase of traffic, which does not at present exist, in consequence of a reduction of the rates. I have considered, that we get no goods from London, in consequence of the high rates. We use a large quantity of brimstone and large quantities of various other articles, of which, in consequence of the very high rates, along the canal and railroad, we never think of inquiring the prices in London; and yet, London is probably the best place perhaps, for purchasing such articles. Large quantities of those articles are imported into London, and we could often get them cheaper in London than in Liverpool. Some years ago, we made communication to the Grand Junction canal company that we could get *chalk* from Harefield, 16 miles from London, that cost us then 25s per on. By making arrangements with the Grand Junction canal company and other canals, we have got that article down to 12s per ton. The consequence is, we use this article in our manufacture, and perhaps get 1500 tons a year from Harefied, which would never have come at all, but for that reduction. We should have otherwise used the limestone of our immediate neighborhood. The same with regard to sand. We used to get that from Lynn, which cost us 40s per ton. We afterwards got it from the Isle of Wight at 30s per ton. It was found to exist on the line of the Grand Junction canal and instead of charging us at the usual rate of 16s a ton, they charged us 2s 6d a ton. We thus got the cost reduced from 40s to 15s; and by that means, we are enable to carry on our manufacture, and but for those low charges, our manufactory would probably have no existence. Ours is the first house which has ever established a manufactory of window glass in that part of the kingdom. All the manufactories for articles of that description are on the coast. The effect of these reductions has been that the Grand Junction canal company have received considerable sums for the transmission of those articles at very low rates, whereas if they had kept up their rates, they would never have come on their canals.—

To the editor of the Daily Evening Transcript. Sir: Permit a stranger from the "far west" to express the peculiar satisfaction which the perusal of an article in your paper of yesterday—noticing the project of a railroad from Boston to St. Louis—afforded one who has for some years past taken a deep interest in the subject of a continuous line of steam com munication from the extreme east to the remotest west of our magnificent continent. It encourages a hope that a *portion* at least, of the press of this city of "steady habits" is not indisposed to extend its co-operation towards advancing a western communication with points more remote than are circumscribed by the limits of your own State. In a short time, a continuous line of railroad will have been completed from Boston to the eastern shore of lake Michigan. This being done, a *direct* line of communication between Boston and the rich and flourishing Territories of Iowa and Wisconsin will have been completed—excepting only a distance of 150 miles, between lake Michigan and the Mississippi. Over this ground the general government has commenced the survey and location of a railroad; and its friends are anxious that the work should not be retarded for want of the influence which a favorable expression of regard on the part of those most interested, would be calculated to produce. The question then resolves itself into this: "Does Boston sufficiently appreciate the importance of a *direct* line of steam communication with fertile regions of the Upper Mississippi, to aid her distant brethren in asking Congress to prosecute without delay, that portion of the work (above referred to) lying within the limits of the Territory of Wisconsin. Fearing I have already trespassed too far upon your valuable space, I close for the present; hoping that you may deem my subject not unworthy some attention. I am sir, very Respectfully, Your obedient servant. IOWA.

Our citizens are wide awake to the importance, in a national point of view, as well as to themselves and to the millions of citizens on the long line—of a continuous railroad communication from Boston to the far west. They consider such an enterprise as worthy of the patronage of Congress. They accordingly, at the last session, caused a petition, signed by a mass of our active men, to be presented by J. Q. Adams, requesting the grant of public lands to aid in the enterprise, all along the long line. This petition like many others for purposes of national importance, was lost in the fog of Presidential electioneering. We trust, however, that it will be taken up at an early day, and be treated as the best measure for the national defence, the carrying of the mails, the advancing the price of public lands, and the advance of the morals and of the prosperiry of the country.

From the proceedings of the annual meeting of the western railroad corporation.

FARE ON RAILROADS.

The railroad system of Massachusetts is becoming daily of greater importance. But few years have elapsed since the first feeble efforts were made to establish the Worcester, road and many were the clouds which obscured its early prospects. Some predicted it could not resist a northern winter; that it would be buried in the drifting snow; that its cost would vastly exceed the estimate, and the travel would not support it. That if ever feasible, it was in advance of the age. At one period in its history, a meeting was called to arrest its progress; and there is no doubt, that many of its most zealous advocates would have sold their dividends for three per cent. per annum. But the road was carried through and crowned with success. The enterprise has been followed by others, and new avenues for trade are now diverging in every direction from Boston, overleaping the barries with which nature has shut out the trade of the interior, and daily widening the circle of our commerce. On the one side we have reached Taunton, Providence and Stonington, and are now pressing on towards New Bedford, Fall River and Nantucket; towns hitherto supplied by New York. On the other we have reached Worcester; are opening a new route through the manufacturing region of Connecticut, to Norwich and New London, and from Worcester are rapidly approaching the great and fertile valley of the Connecticut and the mighty west.

On the north, we are slowly progressing towards Concord, Burlington and Montreal. On the north-east, we are advancing towards Exeter, Dover, Somersworth, Berwick, Rochester, Centre Harbor and Haverhill, Coos and upper Vermont; and on the east, beyond Salem, and towards Newburyport, Portsmouth and Portland.

The railroads in this State, will, within a year from this date, have absorbed a capital of eleven millions of dollars, and their united length will be 300 miles. While we admire these Herculean undertakings, achieved in so brief a period by so small a State, with so great an outlay of capital and so little foreign assistance, and while we congratulate ourselves that they promise so good a return to the capitalist, and so great facilities to travellers, it is well to pause for a moment and consider whether they have answered all the expectations of the public, and are administered in a manner most conducive to the interest of the stockholders. To the citizens of Boston, this inquiry is particularly interesting, since its prosperity has become in a great measure identified with these railroads. Not only are her citizens the principal stockholders, but these roads all converge towards Boston, as a focal point, and there they are soon to connect with the line of steam packets, about to be established between Boston and Lievrpool. When these roads were first contemplated, and the charters asked of the legislature, the public were promised, not only a rapid passage, but also a great reduction in the charges for freight and passage. Has the latter promise been fulfiled:

It is with regret that we answer this question in the negative. Before railroads were established, the usual charge for stage travelling in this Commonwealth, varied from 4 to 5 cents per mile. For this compensation, the driver called for the traveller at his residence, received his trunk and left him at his hotel or dwelling at the end of the route. Several of our leading railroads have made little or no reduction from this charge; one of them, in particular, which has enjoyed a more liberal share of public patronage than it bids fair to receive in future, seems merely to have aimed at destroying all competition and rivalry by its despatch, without any calculation of the benefits it would confer upon the public, or the remunerating patronage it would receive, from a proper reduction.

I do not hesitate to take the ground, that the present charges are too high, both for the interest of the stockholders and the public. It is a general principle, recognized by all intelligent statesmen, that the demand for luxuries increases more rapidly than the cost declines, when the reduction of price occurs. The aggregate value of the sugar, and tea and coffe, sold in England at a low price, greatly exceds the value of the same articles sold in the same market, when higher prices ruled.

Cheap amusements are the order of the day. At this moment, an association is forming in London, to build a concert room to accommodate 8,000 persons, at a shilling each, with a veiw to profit; and while our own concert rooms are nearly empty at a charge of a dollar, we see every week more than 10,000 people attending our music upon the common. Locomotion is the favorite recreation of Americans, and a healthful, innocent, and improving amusement. It is a recreation equally acceptable to the rich and the poor, and which all will enjoy in proportion to their ability. In a country where families increase so rapidly as in ours, and were the growth of new villages, and cities, and manufactories, call the sons and daughters from the paternal home, the claims of kindred induce travelling, and the oppressive heat of summer attracts crowds from the cities into the interior, whose visits are retuned during other seasons of the year.

To illustrate the fondness for locomotion, and the degree to which it prevails, where the price permits, it is merely necessary to advert to the fact, that on the 4th of July last, 7000 people passed over the Eastern Railroad, at an average charge of 43 cents each, and 2000 made an excursion to Nahant, with music, in a single steamer, at a charge of 25 cents each way. Or we might instance the lines of omnibuses to Roxbury, whose low rates haves increased the travel at least a thousand per cent. Travelling, then, with us, is both a luxury and necessary, and must be progressive as the price declines. It is observed,that, in this country, great equality of condition prevails, and the income of the farmer and the artisan falls but little short of the receipt of the the professions. All classes travel more or less; and as travelling is reduced so that it shall cease to be an expensive luxury, they will resort to this pleasing excitement in preference to all others. The expeiment of low fares has been successfully tried iu Belgium, by the government of that country, a rate has been adopted averaging 1 cent to 1½ cents per mile, and the result is an increase of many hundred per cent. In Belgium, some clases of passengers are carried at the rate of eight mills per mile, and by the publication of the Chevalier de Gerstner, it appears, that these low rates furnish a fair income to the State, although the cost of the Belgium roads is double that of the agerage of American railroads, and the cost of sending a train over them is at least equal to the cost of a train moving over our own railroads. Instead of adopting the liberal and enlightened policy of Belgium, the directors of our roads seem to have in most instances, aimed at extracting as much as possible from each passenger;—to have supposed they have done all that was politic or advisable, if they have put down the competition of the stage and the baggage wagon; to have gone upon the assumption, that they have accomplished every thing, if they have received the existing travel, and the gain incident to increased speed, without taking at all into account, the vast travel they might call into existence by a reduced rate of fare, or the attendant benefits they might confer upon Boston and the State.

AMERICAN
RAILROAD JOURNAL,
AND
MECHANICS' MAGAZINE.

No. 3, Vol. VI. New Series. | FEBRUARY 1, 1841. | Whole No. 375. Vol. XII.

Our readers are aware doubtless of the amount of damage to public works by the late severe freshet, which has spread destruction over a greater extent of country than any like disaster for many years. Bridges without number have been destroyed, and several canals have suffered severely, but none so much as the Lehigh canal. The embankment at the dam of the Croton aqueduct has been swept away to a considerable extent, and the disaster in that vicinity, besides the immense destruction of property, was accompanied by loss of life. It is not our intention to enter into a detail of these misfortunes—for the present we desire simply to draw attention to one particular topic connected with them, from which instruction may be drawn.

In all freshets, and particularly in that which has so lately taken place, it will be found that while the severest loss has been in bridges, these structures themselves have very greatly increased the damage to other property besides destroying other bridges. The reason of this is obvious enough. In a narrow gorge an ordinary bridge, with its piers, soon forms with the ice and drift wood, a dam which restrains the flood only until it has reached a sufficient height to sweep every obstacle before it, and then rushing on with the accumulated fragments of mills, houses, bridges, etc., to the next obstruction. The same process is repeated until nothing can resist its fury.

We need hardly say, that in all such situations we would recommend the erection of *wire suspension bridges*—in most cases the cheapest that can be built—offering no obstruction to the flood, and frequently affording superior accommodation by crossing at a height impracticable in any other form of bridge. The action of ice, at all times unfavorable to ordinary bridges, is almost certain destruction whenever its removal is accompanied by freshets. We had occasion last year to call the attention of our readers to the damage sustained by this cause, and to recommend the same remedy we now propose.

We can only account for the slow introduction of the more improved form of suspension bridge, by the want of popular information. The members of the profession are well acquainted with the advantages of this form of construction, having the experience of the European engineers before their eyes. The suspension bridge, although attempted at an early date in this country, has found but few admirers in its present highly perfected state, and it is now the duty of engineers to urge the attention of those interested, to the best models.

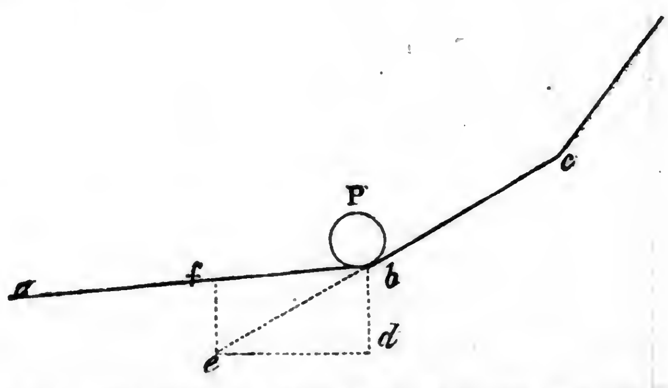
We could not do justice to this subject without advising our readers to turn to the papers of Mr. Ellet, who has done more than any one else to spread information likely to be useful throughout the country. We hope he will not lose the present opportunity to press the matter in the public prints.

For the American Railroad Journal and Mechanics' Magazine.

THE MOTION OF BODIES ON CURVED INCLINED PLANES, AND THE CONTROVERSY, PENDING ON THE "THEORY OF THE CRANK," SETTLED.

The *Theory of the Crank,* as offered by "Fulton," and his objections to my demonstration, which has been the cause of a series of arguments in the Journal, has induced me to investigate the motion of bodies on curved inclined planes more attentively than I have done before, in order to arrive if possible, at a conclusion, which when applied to the *crank motion,* would, from the close analogy of the two cases, bring the matter in dispute to a satisfactory issue.

The following demonstration to that effect has forced itself upon me as correct.



Suppose *a b c*, represent a series of inclines, meeting at *b*, *c*, and

P, a rolling body, arrived at *C*. The direction of the body *P* will then be changed from *c b* to *b a*.

If the direction of the plane *c b* was not changed, but continued by *b e*, the moving force of the body *P*, and which may also be designated by *P*, would continue in an accelerated proportion according to the laws of gravitation.

Let the force, with which the body would continue upon the plane *b a*, be represented by the line *b e*, itself, then we can, by forming the parallelogram of forces *b, d, e, f*, resolve this force into the two forces *b d*, vertical to the plane *b d*, and *b f*, in the direction of the plane *b a*.

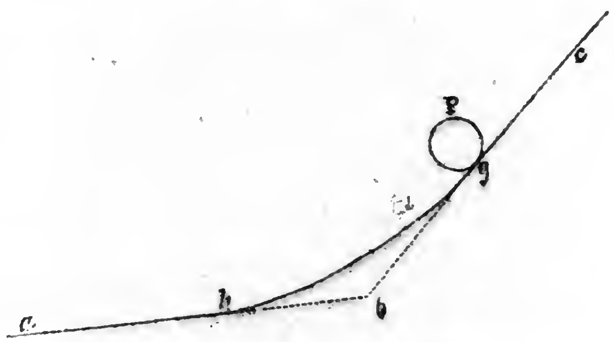
It is evident, that the force *b d*, will have no influence upon the motion of the body *P*, in the direction of the plane *b a*, and that all the force, left for the motion of the body in that direction, is represented by the line *b f*.

b f, being less than *b e*, we see that a loss of power is occurred by the transition of *P*, from the plane *c b*, to the plane *b a*, and that this loss is representented by the vertical *b d*.

Let us denote the angle *a b e*, by α,

The force *b e*, by *P*,

The force *b f*, with which the body will move over *b a*, be marked *F*, then will be $F = P.\cos\alpha$



Now let us suppose, the two straight planes *b c*, and *b a*, instead of meeting at an angle at *b*, be connected by a curved incline, *h g*, to which the two planes *b c*, and *b a*, form tangents. Then the angle *h g b*, which here takes the place of α, is reduced to nought; and as

$$F = P.\cos\alpha$$

and the cosine of nought is equal to the radius, which is here assumed to be 1, we get $F = P.$

Therefore the force *F*, with which the body begins to move over the curve *g h*, is not diminished and equal to the power it had attained when arrived at g.

And from this, I am obliged to acknowledge as a general principle: "That there is no loss of power attended with the motion on curved inclines."

And from the close analogy, which exists between this case and the motion of bodies in curved lines generally. I also admit as a general law: "That no loss of power is sustained by the change from a straight into a rotary motion, or any other curved motion, leaving friction and all other considerations out of view."

The same principle applied to the *crank* I do likewise admit, "that there can be no loss of power connected with the use of the crank, arising from its circular motion."

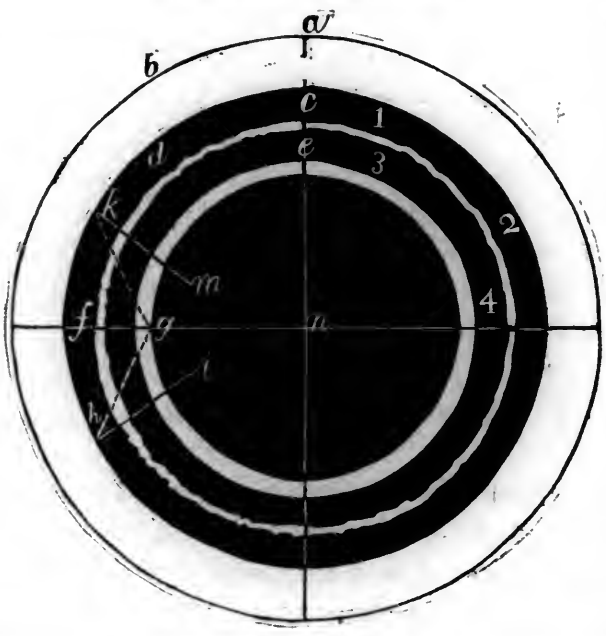
Although I can, as yet, not altogether reconcile my views to "Fulton's" demonstration, and to his last remarks, in reply to me, I feel still bound to say, that I consider myself indebted to the calm and methodical reasoning of that *gentleman*, for the conclusion I have now arrived at.

John A. Roebling, Civil Engineer.

Harrisburg, December 1840.

For the American Rrailroad Journal and Mechanics' Magazine.

MAGNETIC MERIDIAN.



A book has been recently published which is entitled "The Architecture of the Heavens," and in which the author, who appears to have been competent for the task, has collected many of the telescopic observations of the Herschels and of other eminent astronomers upon the regions above us; and, among other things, we are told in the volume in question, that the telescope brings to view many large and somewhat globate masses of matter in the space around us which appear to be in a very rare state; and such is supposed by men like the great Laplace, to have been the original condition of all the bodies of the solar system. The matter of which the earth consists, for instance, is supposed by the most judicious physicians of the age, as appears from their publications, to have been once extended even beyond the orbit of the moon; and to have been gradually condensed to its present dimensions. During this condensation latent caloric was evolved from the matter of which we are speaking, and thus rendered free; and in this latter state, it is supposed to exist now, to a great amount in the interior of the earth; so as to have long since transformed, and to keep the whole in a state of fusion; and, it may be remarked in passing, that, according to this theory, much of the external crust of the earth which is called *secondary*, never became hot enough to be wholly melted, and is consequently, in reality of a *primary* character.

Another remark we have to make by way of introducing our principal subject is, that the circumstance that the rotation of the earth changes the position of the masses of iron near the poles or extremities of its axes but little, while it changes that of those in the vicinity of its equator very much, is a sufficient reason why the magnetic needle should lie as we find it to do, and not in an eastwardly and westwardly direction.

Suppose the matter of the earth to have once extended to the circle at *a* in the accompanying diagram; and that the particle at *a* moved to *b* in the time of one hour. Let it settle, in consequence of condensation to *c*, and it would tend to move the same distance, and even a little further, though that circumstance needs not to be taken into consideration now, to *d* in the same time. Or, in other words, its tendency to preserve its *real* velocity would increase its *angular* one, and that increased angular motion it would communicate in part to what we shall suppose to be melted matter at *e*; but, from that matter it would soon break, and leave the same behind it in its motion upon the common axis.

Again, the matter at *e* would cool to solidity and contract enough to enable it to move faster than would the nucle *n*, within it, but not enough we may properly suppose, to cause it to move even so fast as does the coat or envelope *c*, which surrounds it. And something like this we do actually observe in the concentric rings of the planet Saturn; and, if a segment were cut from each polar region of the earth by a plane passing at right angles to its axis, the remainder would probably exhibit to a distant spectator the same appearance which Saturn now does.

We have further to remark before coming to the point at which we are aiming that from the 19th volume of the Franklin Journal of Science, page 231, it appears that iron at a red heat has no effect upon the magnetic needle; and, consequently, in the case before us we must pay no attention to the melted mass which constitutes the nucle *n* though we may observe in passing that it will be subject to the same tides as are the fluids upon the earth's surface; and those tides will probably rub occasionally against the rough portions upon the interior surface of the coat *e*, which surrounds them; and furthermore the rough portion upon the exterior surface of the same coat *e*, may come occasionally in contact with those of the interior surface of the coat *c*, which lies above it; and thus electricity *may* be developed; and *possibly*, this may be the cause of the polar auroras, as well as of the chemical or electric action, which endogeologists are inclined to think gives rise to the metalic veins that are found in the earth.

Furthermore we have to remark that the metals in the interior of the earth are *probably* so mixed together, that the whole mass is equally fused, though when they cool down to a certain temperature a chemical or electric action takes place *perhaps*, and separates them into crystals or veins; and thus, in my humble opinion, we can imagine something correctly respecting the formation of granite and other primitive rocks.

The figures 1, 2, 3, 4, etc., in the diagram already referred to, indicate masses of iron in the northern portion, suppose for the moment of the coats *c* and *e*; and the resultant of these attractions gives to the magnetic needle a certain direction, we suppose for every different point upon the earth; but soon their relative position is changed, as 1 and 2, in the coat *c*, move faster than do 3 and 4 in the coat *e*; and this will give to the magnetic meridian of any place, as we actually find to be true, sometimes a westwardly, and then again an eastwardly declination. That is, when 3 and 4 are above the horizon of an observer at the equator, their motion will be *relatively* westwardly; and consequently, the northern portion of his magnetic meridian, if it is not counteracted by a southern influence, will decline to the west; but when they are below his horizon, which may be some hundreds of years afterward, their *relative* motion will be eastwardly; and the same portion of his magnetic meridian not being counteracted as above mentioned, will decline to the *east*.

It is well settled by observations, the particulars of which are recorded in our scientific journals, that the resultant of attraction above mentioned, is not the same geographical point for all, and perhaps not, unless accidentally, for any two places upon the earth. That is, suppose the figure before us to be a direct or orthographic perspective projection of the northern or southern hemisphere. *n* being the pole, the concentric circles, parallels of latitude, and the line *f g n*, a part of a meridian. If the needle at *f*, points to *g*, the same at *h* or *k*, would not point there, as indicated by the dotted lines, but perhaps in the direction *h i*, and *k m*.

According to this theory the variation of the magnetic meridian of any place upon the earth will be *periodic;* but it does not thence follow that it will be *uniform;* nor does it follow for a certainty perhaps, that we shall ever ascertain how much faster the coat *c*, moves than does the coat *e*, or the nucle *n*, upon the common axis. At any rate, it is easy to imagine many formidable difficulties that would be likely to present themselves to such an inquiry.

The polar auroras have an obvious influence, as appears from the testimony of many observers upon the magnetic needle; and beyond this we know quite as little about them as we do of the trains of comets, and that is well known to be little enough. Professor Twining gives us, in the 32d volume of the American Journal of Science, some reasons for supposing them to be much higher than is the atmosphere which surrounds the earth; but this needs confirmation. The fact is, they appear to be something like the rainbow, identical to no two individuals. Perhaps the phenomeny in question may prove to be electricity emenating in a certain manner from the earth, and evolving light pursuant to some law in the higher regions of the atmosphere above us. Brewster, the great optician, says, according to the 34th volume of the American Journal of Science, that the light in question does not appear to be *reflected* but *radiated*, or emitted to us.

Since penning the above I find in Hutton's Mathematical Dictionary that the opinion of Dr. Halley respecting the variation of the magnetic meridian are very similar to mine; and would have been doubtless identical with it, had he taken into consideration as I have done, the opinion now prevalent respecting the history and present state of the earth.

OLIVER SMITH.

THREE GREAT LINES OF RAILWAYS, EXTENDING FROM THE CITY OF NEW YORK, TO THE UPPER LAKES,

In the absence of a more full description of the three main lines of railways to the upper lakes, with a fourth branching off at Syracuse by Oswego, lake Ontario, and the Welland canal to lake Erie, the following hasty sketch is given of the enviable portion of the city of New York, to maintain her commercial supremacy.

This is exhibited, and strongly illustruted in the profiles of the routes and distances from this city.

From New York, by Philadelphia to lake Erie, is			534	miles.
From the same by Piermont to Dunkirk,on lake Erie,			484	"
Ditto	by the way of Albany, to Buffalo		470	"
Ditto	Ditto	to Oswego	315	"

Since we have perfected a continuous line of railway from Jersey city by Trenton to Philadelphia, over nearly level ground, it is ascertained, that with the advantage of a large passenger business, and *a goodedge railway*—merchandize may be transported so cheap, as to make New York the seaport of Philadelphia—certainly for the importation of valuable merchandize.

It will be perceived, that the position assumed by Mr N. Biddle, at the State convention at Williamsport in 1838, "*That Philadelphia is* 100 *miles nearer to tide waters, from the upper lakes, then the city of New York,*" is not correct, This statement, however, was made at the period when judge Wright's first survey stated the distance from lake Erie, to Tappan at 483 miles, and to the city hall 508 miles. The distance has since been reduced, 25 miles, also the grades, and inclined planes *dispensed with.* From the city hall to Dunkirk, as survey of E. F. Johnson, is 484 miles.

Since a continuous line of *railway* from Jersey City, by Brunswick and Trenton to Philadelphia has been completed, with the prospect of its being continued to the village of Erie, by Sunbury and the Clarion summit, it is safe to assume, that the best market for the products of Pennsylvania, will be found in the city of New York, and the best outlet to and from the ocean, for at least four months in the year, will be through the narrows, at New York. Not so with the line of railways extending from *Boston, by Albany to Buffalo.* The city of New York, without a continuous line of railways to Albany and Troy, *constructed within the limits* of our State and jurisdiction, and *under one charter,* will have less to boast of, than will the statesmen of Massachusetts in their western railroad. They will have a road less in distance from Boston to the upper lakes, than the boasted line of Pennsylvania.

Heretofore there has been a singular delusion that has engrossed the minds of a large proportion of the citizens of New York, in relation to the Erie, or *southern railroad.* It has been presented to the public, as being of the *first consequence* to the city of New York, *to secure* the entire western trade, to "*compete with Penn-*

sylvania," while the competition with Boston has been lost sight of entirely. It has only been brought to our consideration, since Boston enterprize has borrowed the Dutch bonds of Albany, and purchased their charter, to complete their *Western* railroad from West stockbridge, to the outlet of the Erie canal. A road, (as Mr. E. H. Derby of Boston, observed, from the steps of our Capitol,) "*that will bring Albany within ten hours of Boston, and will virtually make it a sea port on the Atlantic.*"

We contend that the subject of reaching the upper lakes by the most direct route, has not been properly considered by our citizens. We admit that the construction of the New York and Erie railroad is of the first importance *to people* a fertile tract of country, through which it runs, and to connect us with the coal and iron districts of Pennsylvania. These reasons, should be urged by its friends, for its construction. A glance, however, at the profile of this road, with its numerous summits, sharp grades, and its termination, 25 miles from this city, on the *west* side of the Hudson, will make it a mixed line, by railway and steamboats, and of course expensive. This will probably preclude its competing with the line from the village of Erie by Sunbury to Philadelphia, and from thence to New York. It certainly cannot compete with the more favored line from the centre of this city by Albany to Buffalo with a distance of only 470 miles, and easy grades, much less with the route by Syracuse and Oswego to lake Ontario. The distance on this line is only 168 miles, from the lakes to tide waters, or 315 from Oswego to the city hall. This line has advantages, that must defy all competition when its advantages are developed by the construction of 35 miles of railroad from Syracuse to Oswego.

This route must share largely with Buffalo in the western trade. For all practical purposes, "*the trade of the upper lakes is now let down into lake Ontario*" by the Welland canal.

It will be perceived, that by the Ontario route there will be a saving of about 150 miles in tolls and transportation, and a greater use of natural waters, after the goods are shipped. With this advantage, there cannot be a question but that the city of New York can successfully compete with Philadelphia for the western trade, and offer a more certain market for the sale of western produce.

Without the prompt construction of permanent railway from this city to Albany, equal to that constructing by the citizens of Massachusetts, from Boston to the outlet of the western trade, through the valley of the Mohawk by Albany, it is evident, that a large portion of our present trade will be diverted from us. We have more to fear from eastern enterprize, sinee the advantageous introduction of railways, than is admitted by our citizens, who depend on river transportation, to compete with our neighbors.

J. E. B.

For the American Railroad Journal and Mechanics' Magazine.

In the structure of the Croton aqueduct there are some arches which are elliptic while the rest are circular ones; and the latter have about one-fourth more of weight upon their hances than the fomer have; and yet, according to the reasoning of some, they are *both* just right!!!

Did you ever hear, candid reader, of such ridiculous rigmarole before? The arch of equilibration is no arch of equilibration at all, while the elliptic and circular ones, though differing about one-quarter the one from the other, are *both*, it is contended, exactly correct! To be serious, would it not be advisable to put such reasoners into a straight jacket, and send them to the lunatic asylum?

Perhaps you will ask me what I expect to gain by such articles as this, and the one in the last number of this Journal, respecting the Croton aqueduct? Sir—I shall gain this:—I shall vindicate the scientific honor of my country, I shall defend the mathematicians of this vicinity from the imputation of being ignorant of this subject; and we have Adrain, Strong, Gill, Anderson, Ward, O'Shanessey, and others of no inconsiderable eminence, within 15 miles around us. I shall give the Aragos, the Youngs and the Ivories of Europe to understand that we know something, and perhaps as much as they do, of the properties of curved lines; and that the genius of American science did not die with our revered Bowditch. In short, I shall show to the world, that if the worst of all arches must be adopted in the aqueduct bridge which is now being erected over the Harlem river, the reason is not that we have not among us our full proportion of individuals who know how to construct the proper ones. This I am sure of gaining, and perhaps it will be all that I shall be able to accomplish in this case; and even this, insignificant as it may appear to some, will be in my estimation, "glory enough" for one little effort.

It must be borne in mind that the mathematicians of this vicinity will not interfere in this case unless they are properly called upon to do so. I requested the American Institute to give this call, and they promptly, and doubtless very justly, voted that it would not be proper for them, being as they are, not a scientific institution, to do so. The same request I have made to the Mechanics' Institute of this city, and expect the same answer from them. Supported by a considerable number among the first characters here, I have petitioned the common council of this city to take the opinion of some of our eminent mathematicians upon the subject before us, and report thereon, in order that the public as well as their honorable body may be enabled to act understandingly in any further steps which may be thought proper in the premises; and several individuals of both boards, and of both political parties, have assured me that they shall be decidedly in favor of doing so.

Gentlemen of the common council of our city—you will bear in mind that I cannot appear before your body to give explanations, and must therefore give them in this way, if I give them at all. You must be aware that you are not presumed to be judges of this subject yourselves, and that, consequently, it is not *your* opinion which is asked respecting it. Give us the opinion of those who are known to be so, and then the public can do in this case as they please; and if they find occasion to apply to our State legislature for permission to have arches different from those which are intended to be erected in the structure in question they can do so. But you must be fully sensible, gentlemen, that no such application would be of any avail without your concurrence; and shall it be said, during all future ages, that our common council for 1840–1, refused so small a request, supported as it is known to be, by many of our most respectable citizens? Bear in mind that this opinion will cost the city nothing. I know what it will be, in case it is taken; and I wish it laid before the public *officially* and *formally* so that the authors of it may consider themselves responsible for it to posterity as well as to their cotemporaries. The work in question will be always more or less criticised by individuals from all countries; and the fact, whether the constructors did or did not understand the properties of an arch, will be obvious to the scientific observer; and the same pen which records that fact will be very likely to learn either from tradition or written documents, the success of this application. So that the common council of the city of New York for 1840–41 are in the way, at least, of having their names immortalized, either for refusing to give, or for actually giving to science a fair hearing. Yes, the remotest posterity, being probably enabled to single them out by means of this very circumstance, will look back upon them with either contempt or respect. And can an individual of that body hesitate for a moment in choosing which of these he will have his memory to meet?

A copy of this article will be sent to each of the gentlemen who have been here mentioned; and it is presumed that, acquiescing in the demonstration under consideration, he will perceive no occasion to object to the liberty here taken with his name. Should any one, however, whether among them or not so, be of the opinion that the equilibrated arch is not what it purports to be, it is hoped he will give his objections in this Journal, and they shall be properly answered. Neither the writer in the New Edinburgh Encyclopedia who was referred to in my other article of which I have herein spoken, nor Mr. Robison in the Encyclopedia Britanica, whose directions the engineers appear to be following in the case before us, gives any reasons for his wholesale remark in effect, that modern science claims more in this case than is due to her; but besides their gross blunders in quoting the analysis which obtains the intrade when the extrade is given, they make assertions, both of them, in regard to equilibrating a given arch by the synthetic method, which are very far, as I can point out to any competent judge of the subject, from being correct.

But what do you mean, it may be still asked, by equilibrating an arch? I mean, placing the vousoirs so that the line of thrust, commencing at the crown or key stone, will pass from one to another, and thus fall upon the spring or top of the pier. Such is not the case in regard to any arch in the structure of the Croton aqueduct; but in all of them, the line in question runs above the vousoirs and top of the pier into the loose masonry or, perhaps, loose earth, where no provision is made for it. and consequently, it is merely by *accident* that those arches stand. The vousoirs, so far as the thrust is concerned, are entirely useless, and might be removed, provided they were placed upon the top, so as to give the same pressure downward which they now do. Whatever they effect, is due, not to their form and position, as the case should be, but *solely* to the *stiffness* of the material of which they consist. Do you ask, who says so? My answer is, I will convict any one who does not say so, the individual himself being judge, of a total ignorance of the subject. Give us the investigation here requested. It shall cost the city nothing; and the arches that will be thus agreed upon for the Harlem bridge, will contain less masonry and consequently be less expensive than would the ones which are now for that purpose intended, and be as much stronger than they would be as a perfect arch is stronger than is a mere pile of stones and of earth that are thrown indiscriminately together.

Now look for a moment at the progress of science. Descartes first applied equations to curves. Dr. Hook suggested the catenary as an equilibrated arch of the simplest character. Newton, and a few years after him, and independently of him, Leibniz discovered the calculus. Simpson, and perhaps some others before him, applied that mode of analysis to the equilibration of an arch; and the universality of that application was completed about fifty years since by Hutton, and it remains for us, not only to apply the principles thus developed to given cases, but to defend them, and show the objector that he does not understand the subject.

OLIVER SMITH.

FARE ON RAILROADS.

(Continued from page 64.)

Is my assumption correct, that the present rates are too high both for the interests of the stockholders and the public? I will endeavor to show that it is capable of demonstration. The eastern railroad is a case in point. This road has been in operation nearly a year. Its cost has much exceeded the average cost of roads, and as it runs along the seaboard, its principal dependence must be on passengers; yet the directors have boldly tried the experiment of a low rate of fare, and have tried it with complete success. The ratio of increase has been vastly greater than any route; and singular as it may appear, the passengers who weekly enter the city by this eastern road, exceed in number those who enter by all the other railroads. And this road, with little or no income from freight, with an expensive ferry, is already earning more than ten per cent. per annum.

What is the cause of this immense travel, this wonderful increase? It must be ascribed to the reduced rate of charge; and so well persuaded of this fact are the intelligent directors of the road, that they have a further reduction in serious contemplation, and the public need not be surprised if they soon lower the charge to Salem to 25 cents. What will those old gentlemen say to this who predicted at the opening of the road the rate would rise to a dollar? They must feel they were a little behind the age. There is one prevalent mistake upon these subjects. Men reason from experience in stage coaches, not in railroads; the latter are novelties in which few have had experience. Now it is susceptible of proof that no stage coach carrying passengers and their trunks any considerable distannce, can live at a charge less than three cents per mile; but a railroad whose trains shall average two hundred passengers, may pay its expenses at a charge of half a cent per mile, it having been well ascertained by the Chevalier de Gerstner, in his recent tour through the United States, that the cost of sending a train over a railroad is the same throughout Belgium and the United States, viz., $1 per mile, and a single train can easily transport two hundred passengers. It may be assumed, therefore, that a railroad which can command 200 passengers to a train, may transport them 100 miles at an expense of 50 cents each, and in such cases may carry them without loss at one-sixth part of the expense of each to to a stage coach. This difference allows great leeway for a reduction from the stage coach rate, and it is apparent that a road may prove profitable in a populous country at the low rate of a cent per mile; and as there is scarcely any limit to the capacity of a railway for transporting passengers, it follows of course that a population sufficient in numbers and wealth to supply travellers, is all that is requisite to insure the success of a railway at a very low rate of fare. I would not advocate, in the present state of our population, the adoption of this extreme low rate, but I would contend that three cents per mile should be the highest charge upon any of the railways of Massachusetts, and that this rate should be occasionally reduced when we are to compete with our sister States on nearly equal terms for the trade of the interior. But it may be said that the Providence road, with high charges, has thus far made the highest dividends. This is true, but it does not affect the truth of my position, for its success is obviously ascribable to other causes. It has derived an immense patronage from the steamboat competion on the Sound. It is at present the only feasible route between New York and Boston. Its supply of passengers to and from New York is water borne through the Sound at a charge varying from 3-4ths of a cent to 2 1-4 cents per mile, and accomplishing the principal part of the distance at a low rate, they reluctantly pay the extra tax of the Providence road; but this high rate invites competition, and has conduced wonderfully to the building of the Norwich road; and the opening of the latter must soon reduce the rate, or leave the Providence road a beggarly account of empty cars. The Providence road will then, if it reduces, hold a divided empire over the New York travel, securing of course a considerable proportion of it, as it is most direct; but it will find in this very reduction a new scource of income in the general increase of travel. Let the rate between Boston and Providence be reduced, as it should be, to $1,25 for passage, and the charge for freight reduced to $2 1-2 per ton, about the rate now charged by the Lowell road, and the reduction will produce a wonderful accession of patronage; the local travel along the route and between the terminii will wonderfully increase. When the Providence trader can come to Boston and buy his goods at less expense of time and money at New York, he will come often, will buy large quantities of merchandize here, and send it home over the road, which he is deterred from doing now by the high rate of charges. At present he can send his goods from New York to Providence, 180 miles, for less than one half the price charged for 43 miles only on the Providence road; and who sees a Providence customer in Boston? This road, for the purposes of commerce, has thus far been of little or no service to Boston, and one may almost imagine he can see a New York influence in its management; for the New Yorker, in his private speculations, keeps constantly in view the prosperity of the city he inhabits.

What bearing has the history of the Worcester road upon this subject? The Directors originally put the fare at $1 50, and subsequently, at a period of great depression, raised the rate to $2. A little experience has shown that they gained nothing by the advance. Many were deterred from travelling; stages began to interfere with the road, and not a few of the early friends and patrons of the road became disaffected; and the result has been that the directors have recently found it the wisest policy to recede to the original rate; and even this will be found too high when the Western road shall connect it with those great channels of travel, the valley of the Connecticut and the Mohawk. Thus far this road has come in contact with a sparse population only; it will soon reach too of the great arteries of travel, and it will depend in a great measure upon the directors of the Worcester and Western road, whether this travel shall be directed to Boston.

The rates of freight differ upon our several roads; upon the Lowell and Worcester roads they are lowest, viz: on the Lowell a little less and on the Worcester a little over 8 cents per ton a mile; on the Providence as high as twelve cents per ton a mile, or fifty per cent. more than the Lowell, and Worcester, beside an extra charge on many specific articles; this operates as a heavy tax on the transit of merchandize, and materially checks the transportation upon the road. But it may be urged railroads derive their principal profit from passengers, they can make little or nothing upon freight. To a certain extent this may be true. If the charges are so high that little is forwarded, and a train capable of carrying 100 tons, is daily sent over the road with 20 or 30 only, little profit can be made, as the expense of the train is not materially diminished by the reduction of the quantity, except with respect to the charges of lading, unlading, and weighing.

On the Lowell road full trains are sent evry day over the road and, it has almost entirely superseded the canal. It may be inferred, from the recent reports to the Legislature, that the entire expense of transportin a ton over this road does not exceed 82 cents, and as the expense of weighing, lading and unlading and delivery, may be estimated at 37½ cents per ton, the actual cost of transportation cannot much exceed 45 cents per ton, and possbly is less. Thus conducted, the road derives a net profit of about $50,000 a year from its freight, a large part of its income, materially accommodating the public and greatly enlarging its own revenue. Supposing the rate of expense to be the same on the Providence road, the actual cost of sending a full train of merchandize over the road, would be about $1 06 per ton, and a charge of $2 40 per ton, which is the steamboat charge from New York to Providence, nearly 200 miles, would afford a liberal return. It is estimated now, that not one-fifth of the merchandize passing between Boston and New York, goes over this road; a large proportion of the traffic between Canton and the various towns on the route and the seaboard, is conducted by wagons, and the present charges must operate nearly as an interdict on the trade between Boston, Providence, and Taunton. The latter towns receive their supplies by water much cheaper from New York than Boston, and when the New Bedford road is opened, her position will be similar. Let the rate be reduced at least one half, and an active and bustling commerce must spring up between these flourishing towns, a great accession of freight be received by the road, and this collateral benefit gained, that every ton of freight will secure additional passengers. Thus far the Worcester road has had an apology for charging as above because no sufficient return freights offer at Worcester. While the ascending trains average 48 tons, the descending trains bring but 12 back, the cost of transportation is of course enhanced. When the road reaches Springfield, a low rate for descending produce and goods will doubtless command full trains, and a proportionate reduction may be made. An average charge of $4 or $5 per ton from Boston to Springfield, will be proportionate to the sum indicated for the Providence road, and it is to be hoped that this or a lower rate will be adopted.

The great Western road of Massachusetts rapidly approaches completion. Within six weeks it will be opened to Springfield, and the fertile and extensive valley of the Connecticut will at length find an eastren outlet. The ensuing year will witness the completion of this road to the Hudson, its connexion with the railways and canals of New York, and it may safely be predicted, that within the year 1841, the traveller and the mail will pass from Boston to Detroit within sixty hours. The importance of this road, is, and has been appreciated by the public, and deep solicitude has been felt for its success. All doubts as to its completion seem now to be dispelled; the persevering spirit of its originators, the liberal aid of the State and the judicious management by the directors of their scrip in London, insure its successfull progress.

Neither can any doubt remain as to the wonderful despatch it will give both to travel and trade. The question which now arises, is not whether it shall be finished, but how it shall be made most available to the shareholder and the public. The management of the road, when finished, is full as important as its construction. In vain will the millions invested in this costly enterprise have been expended, if the charges shall be such as to prevent or materially restrict its use.

There is a community of interest between the entire State and the shareholders, that this road should conciliate to Boston the trade of the valley of the Connecticut, and a liberal share of the commerce of the North and West.

The success of this noble avenue must very much depend upon successful rivalry of Boston with New York, for the trade of the vast and fertile regions bordering on the Connecticut, the Mohawk and the lakes. It is easy to demonstrate, that this traffic cannot be conciliated unless a low scale of chagres must be adopted ; and the profit of the road must spring from a moderate per centage upon a large amount of business.

With such a scale, only, can Boston compete successfully with New York. This great avenue to the west passes within twenty-eight miles of Hartford, the present head of navigation, and at Springfield strikes a point easily accessible from New York. The distance from Springfield to New York is but 125 miles, and the fare by the river steamboats to New York, is but $3, viz $1 to Hartford, and $2 from Hartford to New York.

Will it answer, then to put the fare between Boston and Springfield above $3? If the country trader, descending the valley of the Connecticut, and arriving at Springfield, shall find that he can reach New York at a less rate than Boston, and can bring his merchandize from the former at a less freight than from the latter, towards which will he turn his face? It requires no astrologer to answer this question. But let the fares be the same, and let the charge of freight be even a trifle more from Boston by the railroad, the latter will have this advantage; it is 30 miles nearer Springfleld, the journey may be accomplished in six hours only, and merchandize received the same day it is purchased. In distance, as well in winter, facilities, Boston will have the superiority, and this must be maintained by a cautious adjustment of the tolls. Still more important will this become, when the Western road shall strike Hudson River, and tap that immense stream of traffic and travel which now brings so rich a tribute into our sister city, New York. When the entire road shall be finished, ten hours will suffice to carry the traveller from Boston to the Hudson, the same period required by the fleetest steamboat for its passage down the Hudson. Through the entire year, then, the road, with respect to speed, will compare probably with the Hudson, and will not, like the Hudson, be sealed up by winter. But the usual cost of a passage on the Hudson is but $3, from Albany to New York; and 15 or 20,000 passengers who are weekly born between Hudson, Albany and New York, in fifteen spacious steamers and seven barges, which daily ply between these points, besides the crowds who sail in the fleets of sloops that whiten the river, pay no more.

This travel is constantly increasing; every link completed in the western chain of roads gives a contribution to it, and every village planted in the west adds its tribute. How is a fair porportion of this travel to be drawn over the western road? It can be drawn by a low rate of tolls only.

Some gentlemen of fortune, who have travelled, but have not studied this subject, will reply that a small difference in charges will not affect the travel; that if they wished to visit Boston, they should not be controlled by one or two dollars excess of charge. A man of fortune might not regard it but the majority of our travellers are not men of fortune; they understand the uses and value of money, and attach a value to the fractions of a dollar; they forget not the maxim of the sage and philosophic Franklin, that a "penny saved is a penny gained;" and where different markets offer equal attractions, they are determined by the difference of cost.

The suggestion I am about to make is a startling one, but, after due reflection, I am satisfied it is correct. I would propose that a concerted arrangement be made by the three companies who form the chain of roads from Boston to Albany, to put the fare for the entire route at $3 as soon as the roads are finished. The roads will compete, both in speed and in price, with the Hudson; and I contend this rate will give to the entire route the greatest income. The cost of sending a train over a railway is, according to the Chevalier de Gerstner, both in Belgium and America, $1 per mile, and such train may with ease carry 250 passegers, weighing, and with their baggage, but 20 tons. The whole cost of sending this train from Boston to Albany, 200 miles, will be but $200; and if the trains should be so arranged (as they may be) to average 200 passengers, the entire expense will be but one dollar per passage, leaving a clear profit of $2 per head at a charge of three dollars. At this rate, 6000 passengers per week, the number which travels over our Eastern road, would give a net income of $624,000 per year, independent of freight, or 9 1-2 per cent, per annum on the entire cost of the three roads.

The Worcester having been estimated to cost	$1,700,000
The Western,	4,200,000
The Albany,	700,000
	$6,600,000

And at this rate, with corresponding rates of freight, it is safe to predict the number of passengers would exceed 6000 per week, or 500 each way per diem. If this computation be accurate, the road could well afford to transport merchandize at a moderate advance on the estimated expense of sending it on full trains, and a double track would soon become necessary to prevent an excess of profit over the rates indicated by the charters.

This result is brilliant indeed, but its very brilliancy may alarm the reader, can such moderate, such inconsiderable charges produce such immense results. To avert the suspicion of being a theorist or a visionary, I will endeavor to anticipate and to answer the objections which may be made. And first would there be travel enough to furnish 9000 passengers per week? I answer, the estimate is too low. What route in New England compares with the Hudson in amount of travel and trade. A careful computation rates the present travel on that stream at 15,000 per week, and in the natural course of things, it must increase next year. Is it not safe to presume that a route to Boston equally cheap and expeditious, will command one fourth that amount of travel? Why not? Boston is the seat of the domestic manufactures; may be bought here five per cent, cheaper than in New York; it is the centre of the fisheries, and two hundred miles nearer England, with which it will soon be united by a semi-monthly line of steamers. It is the best mart for Western produce. If the travel between the Hudson and Boston should be but 4000 per week, surely 2000 per week is a low estimate for the local travel, when the fare falls to less than two cents per mile, half the present rate on the Worcester road. Is the eastern route to be compared with this? Can the little towns of Lynn, Salem Danvers, Newburyport and Portsmouth, furnish more than three times the travel which will be supplied by the valley of the Connecticut, and the flourishing counties which line the road. Instead of 6000, the presumption is that the number will be 8000 or 9000 per week. Again can a train carry 200 passengers over the high grades of the road? The weight of such passengers and baggage would not exceed 16 tons, and one of the improved engines just finished for the Western road, as an experiment; and if it should be retarded at all inscending the high grades, which are but of moderate length, its superior power would make up the loss of time on the level and descending portions of the route.

Have I not taken repairs and contingent expenses into account? In the estimate of a dollar per mile by the Chevalier de Gerstner, as the cost of a train, I understand the wear and tear of the engine and cars, and other current expenses, to be included; but if they are not, the profits of freight must be more than sufficient to cover them and the repairs of the road, leaving the net income from passengers a clear revenue.

The act of the Legislature granting the last loan to the Western road, virtually restricts the income to seven per cent, and the proprietors can gain nothing if the income should exceed six, inasmuch as the loan of the State is at 5 per cent., and the income of the road at 6 per cent., would pay the interest on the loan to the State, and 7 per cent, to the proprietors, partly by the creation of sinking fund. As respects the Western road, therefore, my calculations of profit may be reduced one third, and still the highest rate of revenue permitted by law, be realized by the stockholders. I do not hesitate, therefore, to propose, that on the opening of the Western road to Springfield, the fare from Worcester to Springfield be put at $1 50 or less, and the charge for freight at $2 00, and that efforts be made to bring the Worcester road into a corresponding arrangement.

The directors of the Worcester road are beginning to appreciate the benefits of low fares: their receipts during July have averaged about $5000 per week, at the reduced rates, being $1000 per week more than their average receipts during the past year. Although a portion of this may be ascribed to the summer travel, it warrants me in saying they have increased their revenue by the reduction of their charges; and my knowledge of the intelligence and liberality of this Board, assures me that they will cheerfully make an equitable arrangement as to tolls with the directors of the Western road. A further reduction of fare and freight, attendant on the opening of the Norwich and Western roads, would unquestionably bring a great accession of travel to the Worcester line, and swell its 1000 passengers per week at $2, to thousands at reduced fares. But if there were a doubt as to the policy of establishing such rates on the Western road, the wishes of the shareholders should be consulted, and those wishes are decidedly in favor of the experiment. Who are the proprietors of the road? They are the enterprising merchants, manufacturers, and artisans of Massachusetts; they took their shares not with a veiw to profit, but the advancement of commerce, and the development of the resources of the State; their interests are identified with the interests of the public, and whatever promotes the one conduces the other.

The interests of the public point to reduced rate of fares; I trust they will be consulted. D.

RAILROADS IN THE UNITED STATES. *By L. Klein,* Civil Engineer.

(Continued from page 368.)

RAILROADS IN NEW JERSEY, DELAWARE, AND MARYLAND.

The railroads in New Jersey were constructed by private individuals without any assistance on the part of the State; the most prominent of them is the Camden and Amboy railroad, which is the longest and has been constructed at a great expense. Nearly parallel with the same, and at a small distance only, runs another railroad, and both serve to connec

RAILROADS COMPLETED OR IN PROGRESS IN NEW JERSEY, DELAWARE, AND MARYLAND.

No.	Name of railroad.	From and to where.	Opened. Year.	Opened. Miles.	No. of Miles. Besides graded.	No. of Miles. Not yet const r'd.	Total length of road.	Weight or dimensions of iron rails or bars	Motive power used.	Amount of capital already expended.	Amount wanted for completion.	Total cost of road.	Cost per mile.
1	New Jersey,	Jersey City to N. Brunswick.	1836	34			34	T rail 37 lbs.	9 locomot.	1,800,000	50,000	1,850,000	54,412
2	Paterson and Hudson,	New Jersey R. R. to Paterson	1834	14			14	plate $2\frac{1}{2} \times \frac{5}{8}$	4 locomot.				
3	Morris and Essex,	Newark to Morristown.	1837	23			23	do. $2\frac{1}{4} \times \frac{5}{8}$	3 locomot.	327,000		327,000	14,200
4	Elizabethtown & Somerville.	Elizabethtown to Somerville.	1840	22		4	26	do. $2\frac{1}{2} \times \frac{5}{8}$	2 locomot.	300,000	50,000	350,000	13,462
5	Camden and Amboy,	Camden to Perth Amboy.	1835	61			61	T rail 38 lbs.	} 17 do.	} 2,700,000		} 2,700,000	} 29,348
6	Camden and Amboy Branch,	Bordentown to Trenton and New Brunswick.	1839	31			30	do. 48 lbs.	}	}		}	}
7	Camden & Woodbury,	Camden to Woodbury.	1833	7			7		2 locomot.				
1	Newcastle & Frencht'n	Newcastle to Frenchtown.	1832	16			16	do. 40 lbs.	6 locomot.	400,000		400,000	25,000
1	Wilmington and Susq.	Wilmington to Havre deGrace	1837	34			34	do. 42 lbs.	} 10 do.	} 3,430,000		} 3,430,000	} 49,000
2	Baltimore and Port Deposit,	Havre de Grace to Baltimore.	1837	36			36	plate $2\frac{1}{2} \times 1\frac{3}{4}$	}	}		}	}
3	Baltimore and Ohio,	Balt. to Pittsburg & Wheeling	1834	85	25	325	435	T rail 52 lbs.	16 locomot.	4,000,000	9,000,000	13,000,000	30,000
4	Washington Branch,	B. & O. R. R. to Washington.	1835	$30\frac{1}{2}$			$30\frac{1}{2}$	do. 40 lbs.	4 locomot.	1,660,000		1,660,000	54,426
5	Baltimore and Susq.	Baltimore to York.	1838	58			58	do. 58 lbs.	12 locomot.	} 2,800,000	200,000	3,000,000	44,118
6	Westminster Branch,	Baltimore and Suq. R. R. to Westminster.	1832	10		8	18	plate $2\frac{1}{4} \times \frac{1}{2}$	horses.	}			
7	Baltimore & Annapolis	Elkridge to Annapolis.	1840	$19\frac{3}{4}$			$19\frac{3}{4}$		2 locomot.				
8	Easetrn Shore,	Elkton to Somersetcove.			20	98	118			112,500	1,400,000	1,512,500	12,818
16				$480\frac{3}{4}$	45	435	$961\frac{1}{4}$		87 locomot.				

the two largest and most important cities of the United States—New York and Philadelphia. The railroads in this State have all a single track, the width of which is four feet ten inches. They are used for the transportation of both passengers and freight.

There is only one railroad in the State of Delaware, connecting the Delaware river with the Chesapeake bay. It has a double track, and was commenced as early as 1830. A part of the Philadelphia, Wilmington, and Baltimore railroad, also passes through this State.

In the State of Maryland a great deal has been accomplished in regard to railroads. In 1828 one of the most stupendous works in the Union—the Baltimore and Ohio railroad—was commenced; other railroads of great importance have been undertaken, and are for the greatest part finished. The State government has contributed much to promote the introduction of railroads, by granting loans or taking stock to a very large amount; and the city of Baltimore, aware of the incalculable advantages it must derive from being the centre of so many improvements, has liberally contributed its share to the same object. Nearly all the railroads in this State are of a very permanent construction, with a heavy T rail, and the superstructure resting upon a solid foundation; but owing to the nature of the country through which they pass, very heavy grades had frequently to be adopted. The grading is done for a double track, but only a single track is laid down. The width is four feet eight and a half inches.

REMARKS.—Of the Paterson and Hudson, and Camden and Woodbury, railroads, the cost of construction has not been ascertained, as also of the Elkridge and Annapolis railroad.

The Wilmington and Susquehanna, and Baltimore and Port Deposit, railroads, form with the Philadelphia and Wilmington, railroad (see State of Pennsylvania) only *one* line, denominated the Philadelphia, Wilmington and Baltimore railroad; the total cost of the whole is, 3,930,000 dollars, and the number of locomotives, 14.

In the following summary statement of the railroads in the States of New Jersey, Delaware, and Maryland, the cost of the Paterson and Hudson, Camden and Woodbury, and Elkridge and Annapolis, railroads, has only been *estimated;* their length being inconsiderable compared with the total length of all the roads; the general results cannot be much influenced, should the estimate be a little too high or too low.

Name of State.	Number of railroads.	No. miles in operation.	Total length of railroads.	Number of locomotive.	Amount of capital expended.	Amount required for completion.	Total cost of railroads.	Average cost per mile
New Jersey.	7	192	196	37	5,547,000	100,000	5,647,000	28,826
Delaware.	1	16	16	6	400,000		400.000	25,000
Maryland.	8	273¼	749¼	44	12,400,000	10,600.000	23,000,000	30,700
	16	481¼	961¼	87	18,347,000	10,700,000	29,047,000	30,218

According to the above statement, there are now sixteen railroads in these three Atlantic States, with an aggregate length of 961¼ miles, of which 481¼ miles are already in operation, or nearly one half of the whole length. The number of locomotives employed upon 471¼ miles of railroads is eighty-seven, being at the rate of one engine for every 5.4 miles of road.

The sum of 18,347,000 dollars has already been expended, and 10.700,000 dollars more will be required to put in operation the still unfinished parts of several lines; of the 961¼ miles of railroads the average cost per mile will then be 30,000 dollars.

RAILROADS COMPLETED AND IN PROGRESS IN THE EASTERN STATES.

No.	Name of Railroad.	From and to where.	Opened.		No. of miles.		Total length of road.	Weight or dimensions of iron rails or bars	Motive power used.	Amount of capital already expended.	Amount wanted for completion	Total cost of road.	Cost per mile.
			Year.	Miles.	Besides graded.	Not yet constr'd.							
1	Bangor and Orono,	Bangor to Orono.	1836	10			10		2 locomot.				
2	Nashua and Lowell,	Nashua to Lowell.	1838	14¼			14¼	T rail 57 lbs.	3 locomot.	354,000		354,000	24,842
3	Boston and Lowell,	Boston to Lowell.	1835	26			26	do. 46 lbs.	7 locomot.	1,610,000	190,000	1,800,000	79,231
4	Charlestown Branch,	Bost.&Low'l rr. to Charlest'n	1839	1⅓			1⅓	do. 45 lbs.		91,028		91,028	68,271
5	Boston and Portland,	Bost. & Lowell rr. to Exeter.	1839	34¾			34¾	do. 45 lbs.	4 locomot.	610,000	90,000	700,000	20,144
6	Quincy,	Quincy Quar. to Neponsit riv.	1827	4			4	plate.	horses.				
7	Eastern (in Mass.)	Boston to State Line of N. H.	1839	25	12½		37½	T rail 45 lbs.	8 locomot.	1,306,196	193,804	1,500,000	40,000
8	Eastern (in N. H.)	Portsmouth to S. Line of Ms			10	5	15					600,000	40,000
9	Marblehead Branch,	Eastern rr. to Marblehead.	1839	3			3	do. 45 lbs.					
10	Boston and Worcester,	Boston to Worcester.	1835	44½			44½	do. 40 lbs.	10 locomot.	} 1,848,085		1,848,085	40,000
11	Millbury Branch,	Boston and Worcerter rr. to Millbury.		3¼			3¼	do. 40 lbs	horses.	}			
12	Western,	Worcester to W. Stockbridge.	1839	54½	33	29½	117	do. 55½ lbs.	8 locomot.	2,800,000	1,700,000	4,500,000	38,462
13	Boston and Providence,	Boston to Providence.	1835	42			42	do. 58 lbs.	11 locomot.	1,850,000		1,850,000	44,048
14	Dedham Branch,	Bost. & Prov. rr. to Dedham.		3			3	plate $2\frac{1}{4} \times \frac{5}{8}$	horses.				
15	Taunton Branch,	Bost. & Prov. rr. to Taunton.	1836	11			11		2 locomot.	250,000		250,000	22,727
16	N. Bedford & Taunton	Taunton to New Bedford.			10	10	20	T rail 58 lbs.		151,039			
17	N. Y., Prov. & Boston,	Providence to Stonington.	1837	47½			47½	do. 58 lbs.	6 locomot.	2,500,000		2,500,000	52,632
18	Norwich & Worcester,	Norwich to Worcester.	1839	59			59	do. 56 lbs.	4 locomot.	1,360,000	140,000	1,500,000	25,424
19	Hartford & N. Haven,	New Haven to Hartford.	1838	18	10	10	38		2 locomot.			760,000	20,000
20	Housatonic,	Bridgeport to State Line.	1839	35		38	73		2 locomot.			1,095,000	15,000
20				436	75½	92½	604		69 locomot.				

RAILROADS IN THE EASTERN STATES.

The railroads in the New England States, principally those in the State of Massachusetts, are not only among the most solid and best constructed, but at the same time the most prosperous and profitable in the United States. They were all constructed by private companies; to several of which loans were granted on the part of the States. The oldest railroad not only in these, but in the whole United States, is the Quincy railroad, near Boston, completed in 1827. The longest will be the Western railroad, extending from Worcester to West Stockbridge, a distance of 117 miles; Nearly all the railroads in the eastern States have been graded for a double track, but with the exception of the Boston and Lowell railroad, only a single track has been laid down. The superstructure consists mostly of wooden cross ties upon mud sills, supporting a heavy iron rail of from forty to fifty lbs. per yard. The width of track is uniformly four feet eight and a half inches.

With the exception of a few short branches, locomotive steampower is used upon all the railroads for the transportation of passengers and goods. The income which is derived principally from the conveyance of passengers, is on most of these roads very considerable, and will average fifteen per cent. annually, on the cost of construction, although the latter is higher here than of the railroads in other States.

By an existing law, the railroad corporations in the State of Massachusetts have to make annual reports of the operations of their roads to the legislature. Much information may be derived from these reports, which would, however, be still more useful by containing more detailed data, principally in regard to the expenditures on the lines.

The foregoing statement is prepared from information attained mostly in the winter of 1839, and is therefore not complete; corrections were made from the reports, so as to show the progress of the works up to the end of 1839.

REMARKS.—Of the Nashua and Lowell railroad nine miles are in Massachusetts, and five and a quarter in New Hampshire. Of the Boston and Portsmouth, twenty-five and three-fourths miles are in Massachusetts, and nine in New Hampshire. The Providence and Stonington railroad is nearly entirely in Rhode Island. Of the Norwich and Worcester railroad eighteen miles are in Massachusetts, the remainder in Connecticut.

In giving a summary statement of the railroads in each of the States of New England, the cost of construction of those which are located in two States has been divided in proportion to the length of the line in each of them, as there are no data for a more correct repartition.

Name of State.	No. of r. roads	No of miles in operation.	Total length of railroads.	Number of locomotives.	Amount of capital expended.	Amount required for completion.	Total cost of railroads.	Average cost per mile.
Maine,	1	10	10	2	200,000		200,000	20,000
N. Hampshire,	1	14¼	29¼	2	610,000	300,000	010,000	31,111
Massachusetts,	14	270¼	365¼	52	11,100,000	2,435,000	13,535,000	37,055
Rhode Island,	1	47½	47½	6	2,500,000		2,500,000	52,632
Connecticut,	3	94	152	7	1,905,000	1,000,000	29,05,000	19,079
	20	436	604	69	16,315,000	3,735,000	20,050,000	33,195

There are in the whole 20 railroads in the eastern States, with an aggregate length of 604 miles; of these, 436 miles were in operation at the end of 1839, and the other 168 miles were in progress. Sixty-nine locomotive engines are employed upon 436 miles of roads, or at an average of one engine upon $6\frac{1}{6}$ miles.

The total amount of capital already expended for railroads in New England is $16,315,000, of which $11,100,000 were expended in Massachusetts alone; with an additional sum of $3,735,000 all the railroads hitherto commenced will be completed and the total expenditure will amount to $20,050,000, equal to $33,195 per mile at an average.

In order to give a more general summary view of *all* the railroads in the different States of the Union, the following statement contains a racapitulation of the number and length of railroads in operation and progress in each of the States, of the number of locomotives employed thereon, the capital expended and that required to complete the works in progress, the total cost of the railroads when completed, and the average cost per mile.

Name of State.	Number of railroads.	Number of miles in operation.	Total length of railroads.	Number of locomotives.	Amount of capital already expended.	Amount required for completion.	Total cost of railroads.	Average cost per mile.
Maine,	1	10	10	2	200,000		200,000	20,000
N. Hamp.	1	$14\frac{1}{4}$	$29\frac{1}{4}$	2	610,000	300,000	910,000	31,111
Massachu.,	14	$270\frac{1}{4}$	$365\frac{1}{4}$	52	11,100,000	2,435,000	13,535,000	37,055
R. Island,	1	$47\frac{1}{2}$	$47\frac{1}{2}$	6	2,500,000		2,500,000	52,632
Connecticu'	3	94	152	7	1,905,000	1,000,000	2,905,000	19,079
New York,	28	$453\frac{3}{4}$	$1317\frac{3}{4}$	45	11,311,800	10,503,000	21,814,800	16,570
Pensyl'nia,	38	$576\frac{1}{2}$	$850\frac{1}{4}$	114	18,070,000	5,042,000	23 112,000	27,183
New Jersey,	7	192	196	37	5,547.000	100,000	5,647,000	28,826
Delaware,	1	16	16	6	400,000		400,000	25,000
Maryland,	8	$273\frac{1}{4}$	$749\frac{1}{4}$	44	12,400,000	10,600,000	23,000,000	30,700
Virginia,	10	341	369	42	5,201,000	250,000	5,451,000	14,772
N.Carolina,	3	247	247	11	3,163,000		3,163,000	12.806
S. Carolina,	2	136	202	27	3,200,000	800,000	4,000.000	19,802
Georgia,	4	$211\frac{1}{2}$	$640\frac{1}{2}$	17	5,458,000	4,320,000	9,778,000	15,266
Florida,	4	$58\frac{1}{2}$	217	5	1,420,000	2,400,000	3,820,000	17,604
Alabama,	7	51	$432\frac{1}{2}$	3	1,222,000	3,434,000	4,656,000	10,763
Louisiana,	10	62	$248\frac{3}{4}$	20	2,862,000	1,834,000	4,696,000	18,880
Mississippi,	5	50	$210\frac{1}{2}$	8	3,490,000	2,240,000	5,730,000	27,221
Tennessee,	3	0	$160\frac{1}{2}$	—	1,100,000	855,000	1,955,000	12,180
Kentucky,	2	32	96	2	947,000	1,250,000	2,197,000	22,885
Ohio,	6	39	416	1	420,140	2,859,000	3,279,000	7,883
Indiana,	2	20	246	2	1,375,000	3,425,000	4,800,000	19,512
Michigan,	10	114	$738\frac{1}{2}$	8	1,896,000	5,653,000	7,549,000	10,222
Illinois,	11	23	1421	2	1,832,500	15,177,500	17,010,000	11,970
Total,	181	$3332\frac{1}{2}$	$9378\frac{1}{2}$	463	97,630,440	74,477,500	172,107,940	18,351

It appears, from the above table, that at the end of 1839 *the number* of railroads completed and in progress in twenty-four States of the Union, in which this kind of improvement has already been introduced, amounted to 181, of which $3332\frac{1}{2}$ miles were opened and in use; $1707\frac{1}{4}$ miles were besides graded and ready for the superstructure, and the total length of all the lines undertaken was not less than $9378\frac{1}{2}$ miles.

The number of locomotive engines employed upon all the railroads in the United States, was at that time 463, (about one locomotive for every seven miles of road.)

As accurately as could be ascertained, the total amount expended on all the works, up to the end of 1839, was $97,630,440, the amount still required to complete the works that were commenced, was $74,477,500, and the total expenditure for railroads, when all the works in progress will be completed, will be $172,107,940. If this latter sum be divided by 9378½ (the length in miles of all the 181 railroads) we obtain $18,351 as the average cost per mile of railroad with a single track,* including buildings, fixtures and outfit.

Many of the railroads in progress will, perhaps, cost more than has been estimated for, but even if the actual cost should exceed the estimates by $15,000,000, the average cost per mile of railroad will not be more than $20,000.

Mr. D. Stevenson in his "*Sketch of Civil Engineering in North America,*" (London, 1838,) gives a list of all the railroads completed and in progress in 1837. According to his statement, there were at that time 1652¼ miles of railroads in operation, and 2,760 miles in progress. The extent of railroads put into operation since 1837, or during the last three years, is therefore 1680 miles, being at an average of 560 miles per year; it must, however, be remarked that the extent of railroads put into operation in 1839 was less than might have been expected, owing to the difficulty of raising loans in Europe. If only half the length of lines which were graded had been completed, the number of miles in operation at the end of 1839 would have exceeded 4100, as was anticipated by the late Chevalier de Gerstner.

(To be continued.)

NINTH REPORT OF F. R. HASSLER, AS SUPERINTENDENT OF THE SURVEY OF THE COAST OF THE UNITED STATES, *and of the construction of Standards of Weights and Measures, rendering account of the works of* 1840.

1. The task of the coast survey for the present year, as well as that for the construction of standards of weights and measures, has been in part stated, and intimated in my last yearly report; it has been pursued with all attention and diligence, it was somewhat more complicated than in the preceding years, as may well be expected to be inherent in such kind of works in proportion as they progress.

2. Notwithstanding the calculations consequent to the primary and secondary triangulations, are always carried on immediately after the field work, and in proportion as the data are obtained, a full repetition of the series of calculations was required, and occupied several calculators all last winter, principally on account of the special task of executing the map of the harbor and neighborhood of New York, and by the bringing together upon the, so called, register maps, the full connections of the works, for future use; of these it was required to begin a second sheet for the part of the country south of Raritan bay, to the mouth of the Delaware, which will receive considerable filling up, by the works of last summer.

3. The projection, and reduction of the map of New York, was begun upon the scale of 1 to 30,000, in duplicate, by two assistants separately, both equally reducing from the original topographical maps, resulting from the plane-table works; these two original reductions will verify each other and prevent accidental errors, each of them will have its particular useful destination, which will appear in future.

4. The detail topography of the surveys in the field being grounded upon

* Compared with the total length of all the railroads, the length of those with a double track is inconsiderable.

the triangulation, it is proper that the reduction of the results of it be again grounded upon the same, whenever any part of the work shall be brought into execution, for the construction of a map. To obtain this aim I adopt the following new method; all the triangle points being placed in the projection, made for the map, by their latitude and longitude resulting from the accurate calculations, just mentioned, by their rectangular ordinates, referring to the nearest sides of the respective quadrilateres of the projection, the lines of triangles therefrom resulting upon the map, are used as abscisses, to which every detail point is referred by its rectangular ordinate, referred to the triangle sides.

5. This operation is very satisfactorily executed by rules and rectangular triangles, divided one set upon the scale of the original, the other set upon that of the map to be executed. By this means the union of the great number of detail maps, which in a large work concur in a reduced map, is obtained with the greatest accuracy, and the most ease, therefore also celerity.

I make this detailed statement, because the indication of this method may be of service to gentlemen, who may have similar works to execute.

6. The copper-plates for this map, which had been ordered in Vienna (Austria) have arrived in due time, by the kind assistance of the United States consul Schwartz at that place.

7. All the works here stated have of course required considerable of my personal attention and attendance, they are now in full, active, and regular, progress; adding to this the propriety of finally executing and comparing the number of standards of yards, upon which I have had the satisfaction to report to the treasury department the 10th of July last, there was sufficient good ground for me, to delay my going out in the field, to measure angles for the main triangulation, until later in the season; some of my assistants being engaged, during that time in reconnoitring preliminarily for appropriate station points for these triangles, at the same time that they pursued the secondary triangulation, a work which would have cost to me a considerable loss of time, in travelling about the country, which I considered far better employed in the manner I did.

8. This latter part of the season in which I am now engaged at the main triangulation, has hitherto been very favorable, and promises to continue so still onwards; this is so much more desirable as the nature of the country presents considerable difficulties by its configuration. If the weather of the coming season will allow it, I shall keep the field for the measurement of angles for the main triangles as long as ever possible, after which I intend still, under the favor of the woods being free of leaves, to reconnoitre myself for the discovery of more southern points for the main triangulation.

9. The elevations on either side of the valley of the Delaware, through which the main triangulation must necessarily pass, as has been already stated in my first plan of operation, are so little prominent, the one over the other, that it is difficult to find such as are elevated enough over the others, to afford a view to a sufficient distance, clear from intervening interruption. This occasions of course frequent cuttings of wood upon many hills, which are not always easily acceded to by the owners.

10. The denser atmosphere of the lower countries, and particularly the circumstance consequent thereto; that the rays of light between distant objects pass nearer to the surface of the earth, form a considerable impediment to the good vision required for the work; even the heliotropes, which render so essential services in the triangulation in general, by their light penetrating through a denser atmosphere than any signal, become by it inconveniently large, and diffused. The heliotropes had to be not only con-

siderably multiplied, on account of the number of stations requiring them but also I gave them a new form, easier transportable, and of little work in the construction, and the mirrors of the older ones were reduced, by diaphrams, to less than one-third of their size, to circles of about one inch diameter, this size proved far better appropriated to the shorter distance of the triangle points, and diminished very much the so inconvenient irradiation, which the larger square mirrors present in a denser atmosphere.

11. Two secondary triangulation parties were engaged this year, as habitual, the one following mainly the country west of the Delaware, and southerly to the head of the Chesapeake bay, over which triangles are laid out farther south than last year, the irregular conformation of the elevated parts of that country, and their generally more extended flat tops, lead naturally to equally irregular combinations of the triangles. These works therefore include all the State of Delaware, and parts of Pennsylvania, New Jersey and Maryland.

12. The monuments of the Mason and Dixon line, which are met in the course of this work, were found up, and triangles projected, by which they will be united to the general triangulation, which may afterwards be pursued further southerly and westerly, as well for the purely scientific purpose stated in my former report, as otherwise. It appears that some of the principal monuments at the north end of the line have been moved, and in general that not much attention has been paid to them since a long time; there is however still information enough obtainable for the approximate verification of the scientific result, which, I mentioned as the only use proper for the coast survey work, to make of these monuments, for they do not enter into consideration in that work in their quality of limits.

13. The other secondary triangulation party was engaged in the southern part of New Jersey, laying out a triangulation, from some lines of the other party near the Delaware, towards the Atlantic to the east, and towards the southern extremity to Cape May.

By these triangles the detail works of the Jersey shore, of which the topography had been survey last year, will be joined to the main triangulation, which, as above stated, must pass the shortest way through the valley of the Delaware; and the further continuation of the survey of the Jersey shore, as well for the topography, as for the hydrography, will be grounded upon them in the next operations of that kind, as well on the side of the Atlantic, as on the side of the Delaware.

The absence of all prominent elevations, and the wooded state of all except the lower valleys, renders these operations very tedious and timeconsuming.

14 As stated in my last report, there were yet some parts of the topography in Connecticut and Rhode Island: that had not been reached by the works of the previous years, on account of the close attention which was always given to the wants of the naval parties in the Long Island sound, whom it was necessary to supply constantly with the elments required for their works; the topography of these parts have been filled up this year, and also what remained of the parts of New Jersey to the southwest of Raritan bay, and a part on the Hudson river, yet needed to fill up the map of New York.

15. After the completion of these works, the topographical parties were turned, at different times, upon the parts of New Jersey between the formerly established shore lines of the bay of New York, or rather Raritan, on the north, and the last year's work on Barnegat bay, and that neighborhood, to the east, as far south as the strength of the parties allowed to extend their tasks.

16. In this part of the work will necessarily also be included a part of Pennsylvania in which it has been necessary by the configuration of the country to step over with the main triangulation, so much the more: as an important seaport Philadelphia and its approaches and communications, with the northern parts of the country, form a very essential part of the survey of the coast in that neighborhood.

17. Two naval parties were employed again this year, as formerly, but each of them had two vessels, instead of one as before, the two additional vessels were transferred to the coast survey from the revenue service, one to each party, they are both very well spoken of by the officers having command of the parties, as well appropriated to that service etc; the expenses occasioned by their purchase, their repairs and fitting up appropriately for the service in that work, occasioned of course additonal expenses, which had not been taken into consideration in forming the last year's estimate for the coast survey appropriation, thence contributed considerably to the diminution of the balance of funds now in hand for the coast survey work.

18. Both the naval parties had, like the topographical parties, still to fill up small portions of their work, at the eastern extremity of their former works, on both sides of Long Island sound. The one in Fisher's sound, and the other about Block Island, and the eastern extremity of Long Island These tasks were only of short duration, and of course executed the first.

19. The variations which all seacoasts, and particularly those of our country are subject to in the depth of their channels, made it proper to inquire if any change had occurred in the depth of the northern channel of the bay of New York, discovered by this coast survey; this channel was therefore sounded again in the whole of its separate course; the result was fully satisfactory, indicating rather a small deepening of the channel, than any diminution of depth, so that full reliance may be placed upon its permanency.

20. At the first beginning of the works of the coast survey, I had intended to carry on constant observations of the declination of the magnetic needle, and its variation, at the stations of the main triangulation, by which some data might be obtained, at different parts of the cost, upon this important element of this guide of the navigator, but the general press of the work not allowing to devote time for this purpose, the plan was abandoned after the first year; so much the rather as the main stations lay most generally more inland, than an adequate conclusion, upon the bearing of the needle on the approaches to the shore, could not fairly be drawn from them.

21. But I consider it proper, and advantageous; that at the entrance of the principal ports, such observations should be made once, for a certain time, as will give a proper fixed epoch, with corresponding determinations for this element; such as may be used and referred to in future; and which it will therefore be possible to bring to permanent usefulness, by the guidance of the results of the regular series of observations of the magnetic needle, by which its theory is now so extensively investigated. Such observations may so much the rather be expected to become useful, as a regular magnetic observatory is now established at the Girard College in Philadelphia, as it would be desirable to establish also at other places in this country, in systematic order.

22. With this view there has been made, during the greatest part of last summer, a regular series of observations of the declination of the magnetic needle, at a place near the entrance of the harbor of New York, with a

needle of one foot length arranged for inversion, and constructed for this purpose already in 1813.

The observations were made by observing the magnetic bearing of one of the lines of the triangles of the survey; this will furnish the magnetic azimuth of that line, while the terrestrial azimuth of it is given by the survey, the difference between them is the declination of the magnetic needle.

23. From out of the harbor of New York an excursion for soundings has been made till thirty miles from the shore, in search of accidental notable differences of soundings, which might occur; nothing deserving of special notice has as yet been found, but such investigations are of course to be continued in future.

24. The same naval party executed also, at the same time, with the smaller vessel belonging to it, the soundings of the bays along the outer shore of New Jersey, of Shrewsbury, Barnegat, Tuckertown, and Little Egg harbor about as far as the topography had been extended in that part last year, and elements had been given for the naval operations, to attach the soundings to the topography; the outer shore of that part of the sea-coast was of course investigated and sounded at the same time.

25. The other naval party, after having finished its work in Fisher's sound, was occupied in the river and bay of the Delaware; regular series of observations of the tide were made at different stations from Philadelphia to Cape Henlopen, the whole distance was besides reconnoitred with the view preparatory to the full survey, and accurate determinations of soundings, this will then be grounded upon the points of the two secondary triangulations which embrace more porticularly that river and bay, and those of the topographical survey, to be made of the two shores, simultaneously with these works, like this has been practised for the Long Island sound, and the other inland waters, hitherto surveyed.

26. This survey will require peculiar attention on account of the variability of the courses of the tides, which are different in ebb and in flood, besides their being much varied by the winds, and other circumstances, by which the channels are most likely constantly varied, either temporarily or permanently, so that no chart at present existing is trusted to present any accuracy, though, however, that may have been the case at the time of their construction.

27. When I was in Philadelphia in 1806, Mr. J. J. de Ferrer, a scientific gentleman as well known in this country as in Europe and South America, and I, were consulted upon the means of removing a bar then forming near Fort Mifflin, which was thought to endanger the navigation of the port by permanency; we were both equally of opinion that it would remove itself, by the nature and course of the working of the river, by being removed step by step down the river, until it should find a proper place to lodge its ground, and that so much the rather as a dam, then making at the Jersey shore of the river, with other views, appeared to me to have a tendency to promote this removal of the bar, from its then most unfavorable place; according to all informations this has been the case ever since, and the remains of this former deposite have almost disappeared in distributing themselves in the different opportune places which they met underways.

28. In the view of these circumstances it is evident, that there will be no just comparison possible to be established between the results of the present survey, and the older ones, made at different epochs, the ceritude which the results, to be obtained by the present survey shall give, will therefore be the most important result; establishing a determined state of the river, at a determined epoch of time; perhaps the comparison of it with the older

works may lead to, or at least furnish some data for, what might be called the history of the changes of the river, from which conclusions might be drawn advantageous for the future.

29. The special principles upon which the instruments used in the coast survey have been constructed, have continued always to be very advantageous and appropriate; the shop established in the office, necessary to maintain them constantly in good serviceable order, has furnished besides a number of instruments, and implements, of much superior accuracy, and adaptedness than would have been obtainable in any other way, besides that being always at hand, and every minute ready for such calls as cannot fail to occur constantly in such a work; the gain in time is an additional advantage of great economy, it is therefore of essential benefit, and continually in full activity.

Much of the parts forming in some measure materials for the works, have been procured, others ordered since more or less time, and not yet received, I have so much more hopes to receive them before the next yearly report, as I have had occasion to cause them to be pressed at their place of construction itself.

30. Several years ago propositions were made on the part of the State of Maryland, upon whose territory the coast survey has now entered, to partake in the survey of the coast, by certain arrangements with the Treasury Department, the principal character of which would be: that the triangulation of the coast survey should be made to extend, at the expense of the Government, farther inland, so as to serve as guide for the survey of the State, while the State would, in compensation of this, bear the expense of the whole of the topographical surveys, within its limits, to communicate them to the coast survey; the whole remaining under the same direction, and being carried on upon the same principles as the coast survey has been hitherto.

31. A similar proposition was made in 1817 by the State of New Jersey, when the coast survey was begun in that State, but the interruption of the coast survey at that time interrupted the negotiation. The double advantage that might result from such arrangements, with States partly covered by the coast survey, appears to me very evident, both in respect to the more economical manner in which by this mutual assistance the works would be made, as by the evidently greater perfection of both works, resulting from the greater extension of a regular system; it would equally tend to accelerate generally the final execution of both so desirable works.

32. If any proposition having a tendency to that effect, should be made by the State of Maryland, I wish to recommend it to the favorable consideration of the department; nearer particulars can be matured at the time, when the subject would be agitated, and the advantages to be obtained will then be nearer developed.

33. In relation to the amount of appropriation, which it is desirable to propose to Congress to grant for the coast survey expenses for the next year, I take the liberty to propose again the same amount of $100,000, which Congress has been so kind as to grant the two last years, it will appear by this report as well as by the general tenor of the work, and the state in which it is now, that its progress is just steadily going, adequate to that amount of expenditure, the appropriation being generally nearest expended fully by the time a new appropriation is made, and if any reduction would be required in the general establishment now existing for the work, it would prove a much greater disadvantage, and in fact actual loss, than the amount retained by a lesser appropriation would warrant, or make advisable to expose the work to particularly at the present momentaneous state of

it. I have also no doubt but Congress will willingly grant it, upon the confidence which I believe exists in Congress that the grants made for this work have always been applied with all possible economy, to the best advantage of the country, and that the work executed by their means are of great value for the general interest of the country, and adequate to the grant made for it.

Upon the construction of standards of weights and measures.

1. Since my last yearly report upon this part of my works, which is always, like now, added to that upon the coast survey works, I have had the honor to address to the Treasury Department a letter announcing the readiness for delivery of forty-one yards fully adjusted; having there also said a few words upon the other parts of the works relating to the construction of standards of weights and measures, I shall here take the liberty to refer to that letter for the most part of the account which might be given of these works since last year's report, and relate only what referred to the continuation since then.

2. The direction of the Treasury Department received in consequence of the above letter, having been :-to send to certain named custom-houses eighteen of the yards thus finished, they were placed in proper packing-boxes, with paper wrapped around their inside mahogany fitting-boxes, and delivered to the collector of the customs at Alexandria, to forward according to their respective directions. The other twenty-three were equally packed, and prepared for delivery, the names of the States for whom they are intended are inscribed upon them; they are therefore ready to be forwarded, when called for, upon the invitation which the Treasury Department has directed to these States.

3. The quantity of standards of weights, and the yards for the States, just stated, fully ready and on hand in the office, all reported upon, made it desirable to make room for the other works now on hand, which required the full room again by their increase; with that view I took the liberty to propose, to deliver all this work, fully ready, and reported upon, into some of the vaults of the Treasury Department, for safe keeping; upon the answer of the Treasury Department acceding to this preposition, I delivered seventy-nine boxes of full sets of standard weights, packed ready for forwarding, which were deposited into a vault selected in the Treasury Department. Among these are yet several sets *belonging to States who have not yet called for them,* upon repeated invitations. At the same time there were deposited in this vault the twenty-three boxes of standard yards destined for States, the names of which they are inscribed with. The number of boxes deposited being thereby eighty-two, and the whole number of boxes delivered on that occasion, including the yards for the custom-houses, were one hundred and twenty. This gave room in the office to establish more order, and the free motion necessary to carry on the works still to be done.

4. The works which I stated in my letter of July as in hand, and yet to be executed, have gone on since, in the full proportion to the time elapsed, and will continue at the same rate henceforward.

5. In the winter it will be proper to take up again the revision of the liquid-capacity, measures by weighing, up to their final adjustment, (but the boxes, which shall contain them when finished, are not yet made.) After these operations, which will still occupy some time, it will be possible to begin the adjustment of the half bushels, of which the mechanical work is finished, and which are placed in the boxes already made for them. These two operations of adjustment will be the most tedious of the whole

work, the great attention to be paid to the reduction for physical influences in the weighing, with the daily renewed distilled water, requires much attention, and the long-to-be-continued equal strain of attention in the sameness of weighing, are very fatiguing labor, to which no interest of variation or means of verifying the works, by varying the mothods of operating, can be applied, like I did in the smaller weighings, by introducing a combinatory method, which excites some interest, at the same time that the independent mutual verification, which it affords, relieves the mind of the operator from the anxiety accompanying such operations, upon their success in accuracy; the masses to be weighed are too large to admit combination, which besides would become too complicated an operation. It can therefore also not be expected that they can progress with great celerity, or be pressed onwards in a hurried manner.

6. The plate-glass covers for all the capacity-measures, ordered at the plate-glass factory of St. Gaubin, have arrived in due time, and are fully satisfactory; by this the whole of this part of the establishment of standards, will present the most complete, and extensive systematic collection, that the present state of means, and knowledge admits, and as accurate as the wants of any transactions of the society requires.

F. R. Hassler.

Station Mount Holly, N. J., *Nov.* 17, 1840.

Pennsylvania legislature.—Mr. Johnson, chairman of the inland navigation and internal improvement committee, reported a bill to continue the improvements of the State, of which the following are items:

To pay debts due for repairs done before November 1, 1840.	$268,003
For repairs upon lines of Canals and Railroads, as follows:	
For Delaware Division.	$140,000
Philadelphia and Columbia Railroad.	40,000
Eastern division.	20,000
Juniata Division.	50,000
Allegheny Portage Railroad.	25,000
Western Division.	70,000
Beaver do.	10,000
Susquehanna do.	50,000
North Branch do.	50,000
West Branch do.	25,000
French Creek Feeder.	40,000
Debts due on Sinnemahoning Extension.	1,206
Towards the construction of Reservoirs at the east and west terminations of the Portage Railroad.	150,000
For damages, pay of Canal Commissioners, Appraisers, Engineers, &c.	30,000
For new work on finished lines.	30,000
For motive power on Portage Railroad.	25,000
To the Shenango and Conneaut line of Erie Extension.	600,000
To the Tioga and Tunkhannock line of North Branch Extension,	600,000
To the Sinnemahoning Extension of the West Branch Canal,	100,000
For Allegheny Feeder,	100,000
To Wisconisco Canal,	100,000
For second track and to avoid Inclined Plane at Columbia,	75,000
To complete Dam at Farrandsville,	25,000

The Governor is authorized and required to subscribe for 750 shares of the Union Canal Stock, and give negotiable certificates of loan to the amount of $150,000 in payment thereof.

Also, for 1000 shares of the Bald Eagle and Spring Creek Navigation Company.

The Governor is also authorized, in case of extraordinary freshets, to borrow money on the faith of the Commonwealth.

Mr. Dunlap, from the same committee, reported a bill authorizing the New York and Erie railroad company to extend their road through a part of Susquehanna county in this State.

The Works of Antiquity compared with the Ohio Canal.—Nothing is more common than to hear people speak of the immense works of antiquity, and assert that there is nothing of the present day that will compar with them, and it is customary to hear them say that it must have taken *centuries* to have completed even a single work. Now let us compare the works of the ancients with that of the moderns. Take for instance the great pyramind of Cheops in Egypt. It is estimated to contain six millions of tons of Granite and that it would take all the ships, steamboats and vessels in the world to carry it at one cargo. Now this is all very true, but it was built by a country numbering thirteen millions inhabitants. The Ohio Canal is 209 miles long, of an average width of 40 feet, and must have involved the excavation of upwards of 8 millions tons of earth, besides the stone necessary to build about 140 locks, containing 5 millions cubic feet of cut stone, to say nothing of timber necessary for lock-gates, dams, etc. The Ohio canal was built by a free State, containing a population of less than one million, in the short space of six years and a half! Now how long would it have taken the people of Ohio, numbering fifteen hundred thousand, to have built the pyramid of Cheops? Answer, about *two years and ten days.*

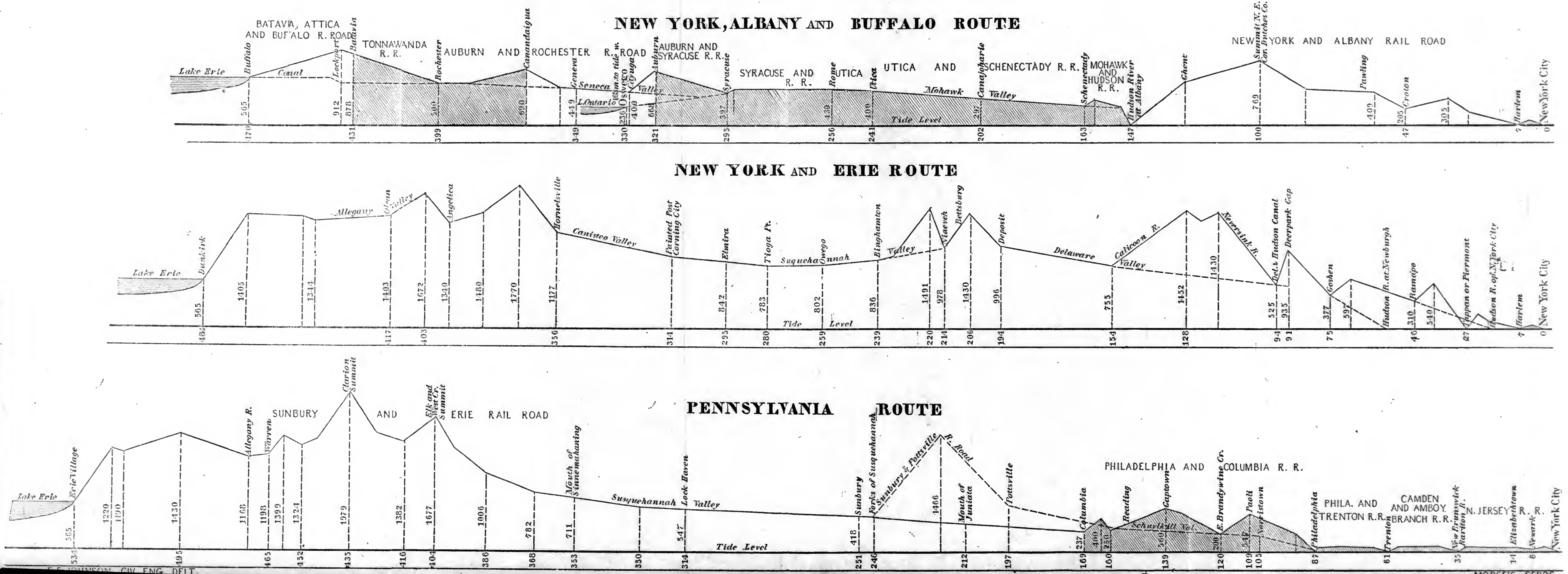
Railway Talking Machine.—A late English journal in referring to the London and Blackwall railroad, mentions a "talking machine" constructed with galvanic wires, by means of which conversation could be carried on between London and Blackwall with the greatest ease and precision. By way of illustrating the efficiency of this talking machine Mr. Stephenson said that he went to the station in London one day to inquire for one of his assistants. He was not there, but the attendant said that he would inquire if he was at the other end of the line; he did so; in a few seconds the answer was that he was not there. But about five minutes afterward the talking machine informed him in London that his assistant had arrived at the Blackwall terminus; upon which he instructed the attendant to say by the same agency, "tell him to come here directly." In ten minutes from that time he arrived, the distance being nearly seven miles. If the distance were 100 miles the conversation could be carried on just as readily, for the communication travelled at the rate of 20 miles a second.—*N. Y. Times.*

Steam Navigation between Bremen and New York.—We are extremely glad to inform our readers (says the Philadelphia *Standard*) that the regular steam navigation between the Hanseatic town of Bremen and New York, will probably commence in the spring. The steamer which is to be built in Bremen, for that purpose, will be of 1000 tons. The shares were subscribed for in two days. But one shareholder belongs to an old family of the city, all the rest, the German papers say, are men originally from the country, who made their own fortunes.

The ship Isaac Newton, now loading at this port for Hamburg, has on board two of *Norris'* Locomotive Engines, worth some twenty-five thousand dollars, destined for a railroad in Prussia.—*New York American.*

PROFILES OF THE THREE GREAT RAIL-ROAD ROUTES EXTENDING FROM NEW-YORK CITY TO LAKE ERIE.

Horizontal scale 30 miles to 1 inch.—Vertical scale 1,000 feet to 1 inch.—The Portions shaded, are complete and in operation.



S. F. JOHNSON, CIV. ENG. DELT.   MORSE'S CEROG.

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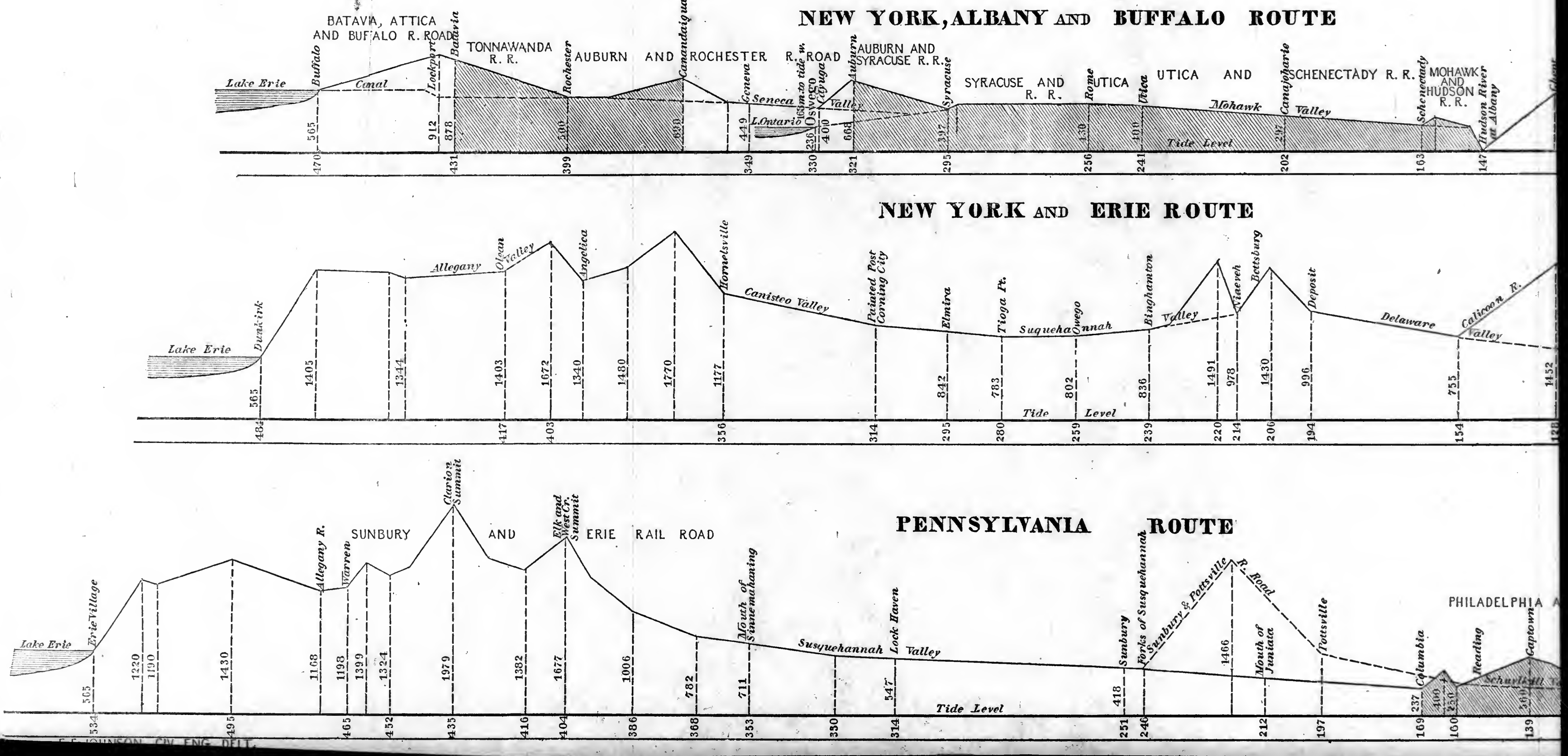

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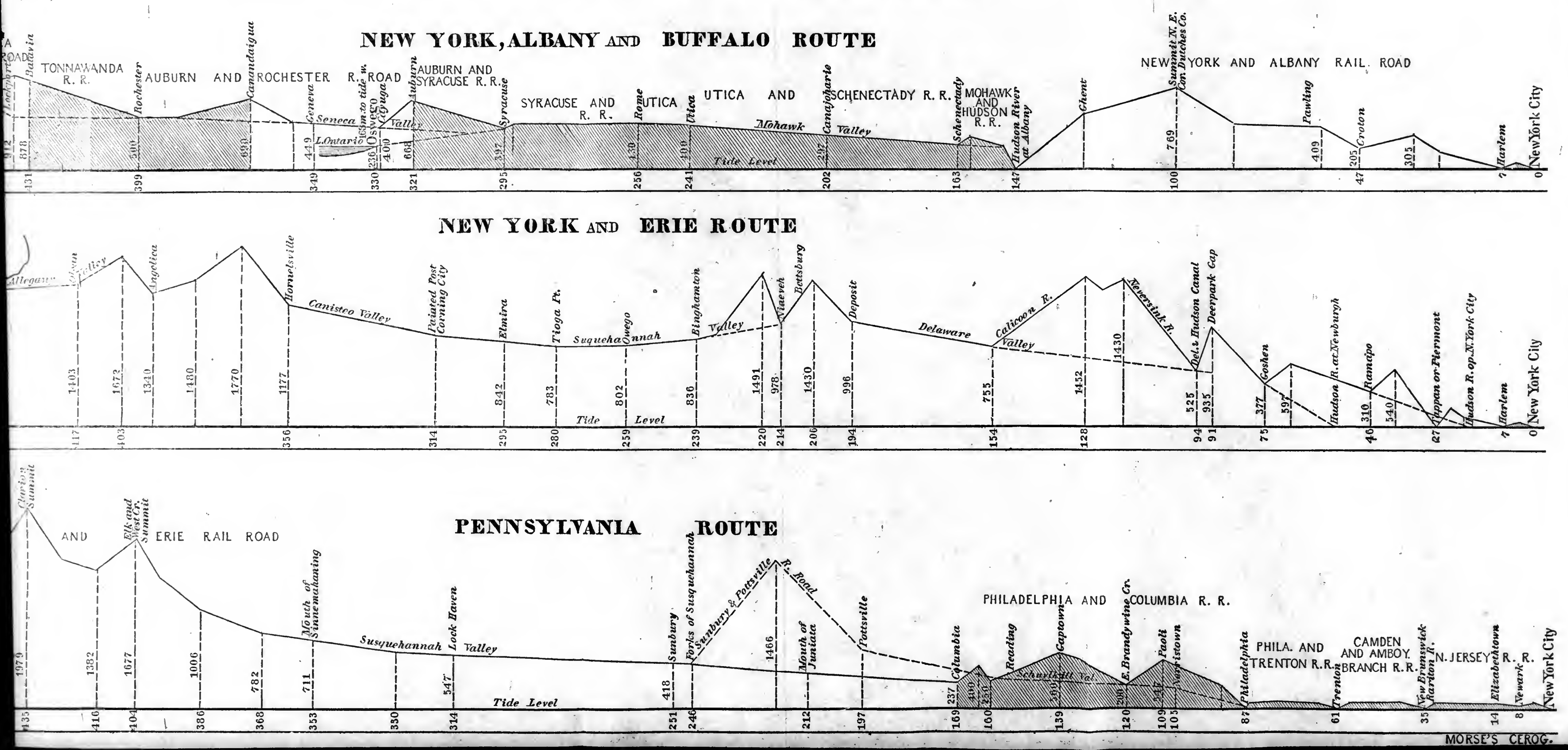

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 4, Vol. VI. New Series. | FEBRUARY 15, 1841. | Whole No. 376. Vol. XII.

ELECTRICITY OF STEAM.

Much curiosity has of late been excited by the announcement of the development of electricity from a steam boiler at a colliery near New Castle in England. Several gentlemen have made numerous experiments upon these boilers and more recently similar phenomena have been noticed in other instances, whenever the suitable precautions have been taken. Instead of encumbering our pages with the mere copy of these experiments, many of them being identical—we purpose giving an outline of all that has been observed.

In the month of October, one of the workmen employed at the above mentioned establishment, perceived a sensation similar to a prick when touching some part of the safety valve. Supposing that he had struck the iron without being aware of it, no particular notice was taken of the fact, until on its repetition it was ascertained that a spark had passed between the finger and the iron. Upon trial, it was found that to produce, the spark, it was necessary that some part of the body should be exposed to a jet of steam issuing with considerable force, from a small leak near the safety valve. These circumstances being communicated to several scientific gentlemen, experiments were made, which resulted in the determination of the following facts.

On touching various parts of the boiler with a metal, no spark was visible until the hand or some portion of the person was exposed to the jet of steam, and the larger the exposed surface, the brighter was the spark. When some good conductor, such as a shovel or a collector armed with pointed wires was introduced into the steam, the sparks were quite long and brilliant, sufficient to charge a leydenjar quite rapidly and to inflame combustibles placed on cotton, etc. In all these experiments it was found that the electricity was *positive.* The pressure of the steam seemed to have a direct effect upon the quantity of electricity, causing it to increase or diminish as the closing or opening of the safety valve produced a change in the pressure. At the time of the experiments the working pressure was 35 lbs. to the inch. It was soon found that these phenomena, depended upon no peculiarity in the structure or condition of the boiler, all that was necessary to their repetition being a jet of high steam unmixed with water or condensed vapor. Locomotive as well as stationary engines have been tried with complete success. The same experiments have been repeated at the United States Mint in Philadelphia, and with the same results.

The cause of the development of this immense quantity of electricity, appears to be generally ascribed to the condensation of steam. One thing is certain, that true gaseous steam when issuing with great velocity, is so poor a conductor as to allow of the return of little or none of the electricity developed, while the steam from a gauge cock by its mixture with the spray of water—and that from a jet of low pressure by its immediate return to vernacular vapor, prove such good conductors as to destroy all evidence of electric excitement.

It might be supposed that the oxidatic of the conductor by the jet of steam might be the source of much if not all of the electricity, but this is disproved by the experiments at the United States Mint where a large bar of 400 ounces of fine gold on being used as a conductor gave the same results as other metals. The human body when employed as a conductor likewise disproves this supposition, as no chemical effects can then take place, the smaller quantity of electricity developed depending upon the inferior conducting power of the human body as compared with metals.

A far more reasonable hypothesis is, that the electricity arises from the friction between the jet of steam and the atmosphere or orifice of the boiler; this however, is refuted by an experiment in which the steam is condensed in a coil of tube kept cool by the usual arrangement, the manifestation of electricity are said to have been as abundant as ever. On our own minds the evidence and experiments adduced to prove that friction is not the agent, have not produced entire conviction, on the contrary some of them seem rather to favor this notion than otherwise.

That the formation or condensation of steam should produce electric excitement is not surprising as experiments have been made long since, which go to show that every change of condition from liquid to gaseous and *vice versa* is attended by electrical phenomena. These experiments were made on a very small scale, and have not received the approbation of men of science in general. But the careful investigation of these phenomena on so large a scale as is offered by the steam engine induces us to hope that the question may soon be settled. When this subject was discussed at a meeting of the American Philosophical Society, several cases were mentioned in which sparks of considerable size were drawn from a stove accidentally insulated and in which anthracite was burning. These cases were brought to afford an analogy to those in which electricity was developed during the formation or condensation of steam.

The question has been asked by many, whether all this has any thing to do with the explosion of steam boilers, we answer decidedly, nothing whatever, for it needs but little knowledge of the principles of electricity or chemistry, to inform us that even supposing the existence of an explosive compound inside of the boiler, no explosion could take place from the highest charge that could be communicated to an insulated boiler, while in fact boilers are scarcely if ever insulated, and then the electricity of steam can cause a spark to take place under the most favorable circumstances only on the outside of the boiler. It is very probable however, that many of the appearances of flame at the moment of explosion have been caused by the spontaneous discharge of a cloud of vapor rendered highly electrical by the immense quantity of very high steam suddenly and simultaneously condensed; the phenomena therefore in this supposition is the effect and not the cause of the explosion.

It has been the fashion in modern times to ascribe nearly all the phenomena of nature, to the agency of electricity, the misconception of the vulgar, and the prejudice of philosophers have alike tended to this end—consequently no new experiment or discovery, in which electricity has the least to do, is ever suffered to escape universal attention, but is generally taxed in some way or other to account for half the phenomena of the universe, sometimes for all of them. The popular nature of these experiments upon the electricity of steam have led and probably will lead to many wise and learned (?) disquisitions by those who know little or nothing about the matter.

RAILROADS FROM NEW YORK CITY TO LAKE ERIE.

In this number is presented to the readers of the Journal, a profile of the great railroad route, leading from New York city to lake Erie by the way of Albany.

This route is arranged into eight divisions, for each of which there is a separate act of incorporation as follows:—

		Distance in miles.	Miles completed.	Miles under contract
1	New York and Albany,	147	11	110
2	Mohawk and Hudson,	16	16	
3	Utica and Schenectada,	78	78	
4	Utica and Syracuse,	54	54	
5	Auburn and Syracuse,	26	26	
6	Auburn and Rochester.	78	35	43
7	Tonawanda,	32	32	
8	Batavia and Buffalo,	30		
	Total,	461	252	153
				252

Complete and under contract 405 miles, not under contract 56 miles.

The line from New York to Albany passes over ground elevated from 300 to 400 feet above tide, the most elevated point being 769 feet above tide. This point is situated near the S. W. corner of Massachusetts, the general course of the line being such as to pass near the West line of that State and of Connecticut, at a distance of 20 to 25 miles from the Hudson River.

From Albany to lake Erie, the route follows nearly the course of the Erie canal, departing from it on the South between Syracuse and Rochester and between Rochester and Buffalo. The ground on this portion is elevated from 400 to 600 feet above tide, the highest point being situated between the Genesee river and lake Erie, and elevated 912 feet above tide.

The grades on this route from New York city to lake Erie, seldom rise as high as 30 feet per mile, there being but four points where this limit is exceeded and the distance in each case being short. These points are situated, two of them, between the Hudson and Mohawk rivers—the third on the Auburn and Rochester road, and the fourth on the Tonawanda.

The Mohawk and Hudson road, which was the first constructed, is graded for a double track, and has a double track superstructure supported for most of the distance upon stone blocks. This road has two inclined planes operated by stationary steam power, which it is purposed to avoid, by steep grades, such as may be surmounted by locomotive engines.

The railroad now building between West Troy and Schenectada and which is intended also to form an important link in the chain of railroads to Buffalo, has a maximum grade of 60 feet per mile. This may be connected with the New York and Albany road by the continuation of the latter to Troy, and will increase the distance to Buffalo about 6 miles, making 465 in all from New York city.

The Utica and Schenectada railroad is graded for a double track, and has a double track superstructure for one-fourth of the distance.

The Utica and Syracuse road is graded for a single track one half of its length and has a single track superstructure. The remaining half is a single track supported upon piles. The expense of this road would seem to show that on ordinary ground but little if any thing is saved in the first cost by the piling system, while the *ultimate* expense is probably increased.

The Auburn and Syracuse railroad is graded for a double track in the most permanent manner. The amount of perishable material in the road-bed not exceeding in value $4000. It passes probably over the most difficult ground between Albany and Buffalo, and has a single track superstructure.

The Auburn and Rochester road so far as completed is graded for a single track, with a single track superstructure. The course which it pursues is not very direct, in consequence of which the distance from Syracuse to Rochester is full 13 miles further than it would have been if the route near the Erie canal had been taken.

The Tonawanda road is graded for a single track and has a single track superstructure. This road has been in operation about 6 years.

All the roads above mentioned have a timber superstructure, the timber rail being surmounted by an iron bar or plate $2\frac{1}{4}$ by $\frac{5}{8}$ to $\frac{7}{8}$ inches. This is in fact the plan adopted upon all the railroads in the State, with the exception of the Long Island railroad and the New York and Erie road. The work upon the unfinished portions of the Auburn and Rochester road is in progress, and arrangements are making for the construction of the portion between Batavia and Buffalo. This road is represented in the profile as passing through Attica. It seems to be the determination now to carry it on the direct route, which lessens the distance 9 or 10 miles, making the total distance from Buffalo to New York city, as above 461 miles; or to tide water and steam navigation on the Hudson at Albany only 314 miles. This is by far the shortest and most favorable route for connecting lake Erie with the tide waters of the Atlantic.

Several of the railway companies between Albany and Buffalo are subject to restrictions in the transportation of freight and passengers. The Utica and Schenectada company, are not permitted to carry freight on any terms, and can charge only four cents per mile for passengers. The Syracuse and Utica, Auburn and Syracuse and Auburn and Rochester companies, are permitted to carry freight by paying to the State the same tolls that the State would have received, had the freight passed upon the canal. These companies are not allowed to charge over five cents per mile for each passenger.

The restrictions as it regards the conveyance of freight, evinces an illiberal and short-sighted policy on the part of the State, and the more so, as the State is squandering millions in the enlargement of the Erie canal.

One-third of the money which it will cost the State to make this enlargement would build an entire new double track, solid iron railroad from Buffalo to Albany—which, if located on ground as favorable as that occupied by the canal, making the line level or descending from Buffalo to Albany, would have double the capacity of the canal when enlarged, convey freight at less cost to the public in one-fifth of the time, and afford a greater revenue to the State. The construction of a railway from Albany to Buffalo, to be operated by locomotive steam power, was urged instead of the canal, in the first instance, by Col. John Stevens of Hoboken, N. Jersey, in 1812. The arguments which he adduced were never refuted—and notwithstanding iron railroads had then never been used for the general purposes of trade and travel, and had never been operated by locomotive steam power, it is surprising how very near the engine proposed by Col. Stevens approximated in the dimension of its several parts and degree of steam pressure to those now in successful operation on most of our railroads.

The road from New York to Albany has been commenced, and a large portion of it has been put under contract for grading, extending through West Chester, Putnam and Dutchess counties. Its progress for several years past has been retarded—first, by an unfavorable report of an Engineer,* who represented that a route could not be obtained within the limits of the State without resort to a tunnel or inclined planes, operated by stationary steam or horse power—secondly, by the derangement which has for some time prevailed in the monetary affairs of the country, and thirdly, by the opposition from rival interests, particularly from the New York and Harlem railroad company. This latter opposition has, within the last year presented itself in a new form, by an unexpected claim on the part of that company to the exclusive right to Westchester county. The N. Y. and Harlem railroad company is in possession of a

* Judge Wright.

road upon New York Island 7½ miles long, which is greatly in debt and does not pay interest and expenses, having cost over 1,200,000 dollars.

That company is so deeply involved, that if they had the exclusive right; which they pretend to have to Westchester county, they could not, in all probability, construct a road through it. Their opposition must, therefore, be attributed to a desire to raise their credit and extricate themselves from present difficulties by coercing an arrangement with the N. Y. and Albany company, on terms as favorable to themselves as possible.

Notwithstanding these embarrassments, the New York and Albany railroad, has continued to advance and will be pressed steadily forward to a completion, and there is now little doubt, that ere two or three years at most have elapsed, there will be a continuous line of railroad in operation from New York city to lake Erie by the way of Albany, on a route much superior, in a topographical and commercial view, to any other which can be adopted. This route will also be connected, in the same time, with steam navigation on lakes Ontario and Champlain by a branch of 35 miles to the former and 40 miles in length to the latter, and also with the railways of New England.

ESTIMATE OF COST PER ANNUM, OR SEASON, OF RUNNING A FIRST *class steamboat, between Albany and New York—average passage both ways eleven hours.*

Cost of boat $70,000, at 7 pr. ct. per annum,		$4,900
Wear and tear of ditto, at 12 per cent per annum.		8,400
Fuel, 40 cords per trip, for 240 trips in 8 months, at the average price of wood in Albany $6 and N. York $5,		52,800
Insurance or $70,000 at 3 per cent,		2,100
Wharfage, agencies packing, tiller ropes, printing bill, etc.		3,000
Wages, to wit :		
First Captain, for the year,	$1,500	
Second ditto,	1,000	
2 Pilots, to relieve,	1500	
2 Engincers, do,	1500	
6 Firemen—8 months, at $20 each,	960	
10 Deck hands, do	1600	
Steward of supplies,	800	
12 Waiters at $15 each, 8 months,	1440	
		10,300
Total expenses for one season, or $339 per trip		$81,500

The above estimate has been reviewed by practical men connected with the steamboats on the North river, who gave the principal items, and particulars of wages. Should the estimate of wood, be considered too high, let 20 per cent be deducted—still each trip would cost $295

Every expense of motive power, according to de Gerstner and others, will be covered by one dollar per mile, per trip, for an engine and train, to carry 800 passengers from the city of New York to Albany, at the rate of 25 cents per hour—to include stoppages—equal to $147

It will thus be perceived, that five hours less in time, and fifty per cent less in the cost of transportating a passenger, may be accomplished, on the completion of a *good edge* railway, compared with the steamboats on the river. J. E. B.

GREAT PERFORMANCE OF A LOCOMOTIVE ENGINE.—On Friday last, the 5th inst., the locomotive engine 'Hechens and Harrison,' built by Messrs. Baldwin, Vail & Hufty, hauled to Phiadelphia, over the Philadelphia and Reading Railroad, ONE HUNDRED AND TWO BURDEN CARS, loaded with the following articles of freight:—1479 bbls. of flour, 49 tons of iron, 1163 bushels of grain, 12 tons of wiskey, oil and ship stuff, and sundry other freight, amounting in all to 251½ tons of 2240 lbs. weight of cars 168 tons, making total weight of 419½ tons of 2240 lbs. by the engine. The average running time of the train was 10¾ miles per hour. Weight of engine with water and fuel, 12 tons; weight on driving wheels, with water, fuel and two men, 6¼ tons.

As the above was the regular freight train, transporting the ordinary business of the road, and no experimental trip, no account was kept of the quantity of fuel or water used by the engine. Length of train 1201 feet; longest continuous level over which the above train was hauled, at a speed of 10⅓ miles per hour, 9 1-10 miles.—*U. S. Gazette.*

HARTFORD AND SPRINGFIELD RAILROAD.—We learn that five different routes have been surveyed between Hartford and Springfield, and that the Engineer will make his report to the General Committee having charge of the undertaking, at their meeting in Hartford to-day. In the mean, time we are informed by a Hartford gentleman, that 20 of the 24 miles can be run in a continous straight line, with no grade exceeding 25 feet to a mile. No Railroad in New England, it is believed, can show such a line. When this short section of 24 miles is made, there will be a Railroad the whole distance from New Haven to Boston, and also (on the completion of the Western Railroad) from New Haven to Albany.

LONG ISLAND RAILROAD.—Thirty miles of this road are completed and in active operation. Twenty miles further are graded in part; the remaining distance is forty-five miles, making in all ninety-five miles. The Company has expended of its own funds upwards of four hundred thousand dollars. This sum has not yet been realized; but the Company is about to receive and apply it, and is it comtemplated that by the 1st of September next, the whole amount of the loan will have been expended, and that at that time or soon thereafter, twenty additional miles will be completed and in operation.

SECOND REPORT OF THE DIRECTORS OF THE NEW YORK AND ERIE RAILROAD COMPANY, TO THE STOCKHOLDERS.—*February 3d*, 1840.

At a meeting of the Board of Directors of the New York & Erie Railroad Company, at their Office, No. 34 Wall street, on the 3d day of February, 1841, the following Report having been read by the President, was adopted, and ordered to be printed and distributed to the Stockholders.

The Directors had it in view to submit the present Report to the Stockholders on the occasion of opening the Eastern Division of their road; but that event having been hindered by delay in the arrival of a part of the requisite iron, and the effects of an extraordinary storm having occasioned a further postponement, they trust that a notice of their proceedings, of the progress of their undertaking, and of various matters relating thereto, will be acceptable at the present time.

It being about five years since the date of the first Report, a reference to the principal events of that period will be expected.

The consideration that the Southern tier of counties had just grounds of reliance, recognized and sanctioned by the Legislature during the construction of the Erie canal, for timely and liberal aid from the State towards opening for them a thoroughfare from the city of New York to lake Erie, entered largely into the view of those who originally proposed the construction of this road. The project of a State road, brought forward under the auspices of Governor Clinton, and surveyed in 1825, had failed for want of harmony in relation to its details; soon after which, the subject of Railways began to attract the attention and confidence of the public. In 1832 the charter of this company was granted. In 1834 the route of the road was surveyed, under the authority and at the expense of the State; and in 1836 the Legislature granted to the Company, in aid of its construction, a loan of the credit of the State for three millions of dollars.

The law pledging this aid provided for the issue of the loan in large instalments, on the completion of specified Divisions of the road. The Division on which, under that act, the work was commenced in 1835, extended from the Hudson & Delaware canal to the Chenango river, and required on the part of the Company an expenditure of about two millions of dollars, before any portion of the loan could be received.

The commercial and financial embarrassments which commenced about the close of 1836, occasioned a suspension of the work until 1838, when the Legislature so modified the law as to authorize the issue of $100,000 of State stock for every like sum which had been or should thereafter be collected on the stock of the Company, and expended on their undertaking; provided, that prior to any such issues, ten miles of the road at the Eastern and ten miles at the Western termination should be located and put under contract.

The then Board of Directors accepted this law, and in August, 1838, entered into contracts for the grading, bridging and masonry of the prescribed portions of the road.

Of collections on the stock of the Company expended on the road, the amount up to the close of 1838, was $346,237.50, which entitled the Company to receive only $300,000 of State stock until the further sum of $53,762.50 should be collected and expended.

It however appeared that the contracts on the two portions of ten miles each, including the pier in the Hudson, land and damages, engineering, and contingencies, would amount to not less than $350,000. A loss of $55,000 was incurred on the sale of the $300,000 of 4½ per cent. State stock first received; so that for discharging these contracts there was a deficiency of means to the extent of about $100,000.

Owing to the continued pressure of commercial embarrassments, it was deemed inexpedient to call on the Stockholders in the city for further payments, until a more favorable state of things should occur.

A disposition was nevertheless manifested by the inhabitants of several of the interior counties, to subscribe to the stock of the Company, and to pay instalments thereon, on condition that portions of the road in such counties should be put under contract; which disposition was encouraged by resolutions of the Board of Directors, and by a circular issued with their sanction.

Subscriptions in several of the counties were accordingly made, and pursuant to the stipulations of the Company, an instalment having been paid on the shares subscribed in Rockland and Orange counties contracts were entered into in July, 1839, for the grading and masonry of thirty-five miles of the road, extending from the ten miles previously contracted for in Rockland, county to the village of Goshen, and for a short distance near Middletown.

The collections on these subscriptions, added to balances received of instalments previously called on other stock, extended the amount of receipts on the stock of the Company, and of expenditures thereof before the close of the year, to something over $400,000; and therefore entitled the Company to the fourth instalment of $100,000 of State stock, which was accordingly issued in December, 1839.

Pursuant to the same views and understandings, contracts were entered into in February, 1840, for the construction, chiefly with piles, of one hundred and seventeen miles of the road between Binghamton and Hornellsville, denominated the Susquehanna Division.

In April, 1840, the Legislature further so modified the previous laws, as to authorize the issue to the Company of $100,000 of State stock for each $100,000 previously collected on the stock of the Company; and the like sum of $100,000 for every sum of $50,000 which should thereafter be collected on their stock, and expended in the construction of the road, till the issues amounted to $3,000,000.

Under this act four instalments of $100,000 each, of State stock, bearing interest at the rate of $5\frac{1}{2}$ per cent., were received and expended in the course of 1840: the construction of the road on the Eastern and Susquehanna Divisions, was diligently prosecuted: the graduation, including masonry and bridging, of ten miles at the Western termination, was finished: that of forty-seven miles in the counties of Rockland and Orange, so nearly perfected as to receive the superstructure, which was provided and most of it laid: the pier in the Hudson, at Piermont, was enlarged: part of the buildings required at that station and at Goshen, were erected: 5000 tons of heavy edge rails, with the necessary chairs and spikes, were purchased: three locomotive engines, weighing fifteen tons each, and four large eight wheeled passenger and a number of freight cars were also purchased, with other requisites for putting the road in operation from Piermont to Goshen: thirty miles of the road on the Susquehanna Division were prepared for the superstructure, besides one of the larger class of bridges: and the entire line of the road west of Goshen, excepting forty miles on the Delaware and ten miles near Dunkirk, which had previously been located, was re-surveyed, and most of it prepared for final location.

Since the passage of the law of April last, collections on the stock of the Company, up to the present date, have been received and duly expended, to the amount of about $220,000; entitling the Company to $400,000 of the State loan, of which sum $200,000 have been received since the 1st of January, 1841.

During these proceedings, the attention of numerous individuals of this and neighboring States, has been drawn to the subject of the road, its route and relations, the plan of construction, and the affairs and prospects of the Company; and a growing confidence on the part of those interested, and of others, who have taken the trouble to inquire, has been abundantly manifested.

In the course of the year, it appeared probable, that the work not already let, might be put under contract on satisfactory terms, and to parties who, after due examination, would be disposed to subscribe to the stock of the Company. Proposals were accordingly received, and contracts have been concluded for grading the road-way from Middletown, near Goshen, to the mouth of Calicoon creek, on the Delaware river, a distance of sixty-five miles; for completing the unfinished sections on the forty miles between the latter point and Deposit, of which, about thirty miles were graded, under the contracts of 1835; and for constructing about one hundred and twenty-four miles, extending west from Hornellsville to the ten miles previously completed near Dunkirk.

The parties with whom these extensive and important contracts have been made, are of the ablest, most experienced, and most intelligent contractors in the country. They have examined the route, claims and prospects of the road, and have shown their confidence in the undertaking, and their satisfaction with the plans and views upon which it is conducted, by subscribing for stock of the company equal, in some instances, to one-third, and in others, to three-eighths of the amount of their contracts, on which they propose to pay instalments as their work proceeds; and they are believed to be well able to hold their stock, make the necessary advances, and complete the payments on it, by the time their work shall be accomplished.

In these, and all other instances of subscriptions by parties with whom contractsfor labor or materials have been made, the stock is regarded and taken as fully equivalent to cash. In no instance, has any higher pricebeen paid to those who have subscribed for stock, than would have been paid, had no such subscription taken place. On the contrary, it has in numerous instances happened, that higher prices have been paid to persons who refused to subscribe for stock, than have been paid to stockholders, for like materials and work. This results from the most obvious considerations, and involves nothing incredible or surprising. Those who have examined the route and plan of the road, the character and resources of the country through which it passes; its very moderate cost, and its relations to the rivers, canals, railways and routes, which intersect it, and to the commercial capital of the country on the Atlantic, and to the lakes, and regions of the west; have perfect confidence in the safety, productiveness, and value of the stock, and regarding their subscriptions as the best investment they can make, are disposed to limit them only by their ability to hold the stock till the road is completed. Those, likewise, who reside near the road, who desire, and are interested it its progress, and are friendly to, and have confidence in the measures adopted by the Company, are disposed to aid in its construction, not only by subscribing to the stock, but by furnishing materials and labor at the most moderate prices; whereas, those who, from ignorance, selfishness, or other causes, are unfriendly or indifferent, will neither subscribe for stock, nor furnish materials or labor without the highest prices attainable under the circumstances which occasionally render it necessary to obtain supplies from them.

Passing from this rapid sketch of their operations, the Directors proceed to state more particularly:

I.—THE PROGRESS AND STATE OF THE WORK.

The following portions of the roadway are graded and otherwise prepared for the superstructure: viz.

		Miles.
From Hudson river at Piermont to Goshen, on which the superstructure is mostly laid, - - - -	45	
Near Middletown, - - - - - - - - -	2	
On the Delaware, between Deposit and Calicoon creek, forty miles put under contract in 1835, and suspended in 1837, about, - - - - - - - - -	30	
On the Susquehanna, between Owego and Hornellsville,	30	
At Dunkirk, - - - - - - - - - -	10	
	——	117

Portions now under Contract.

On the Susquehanna Division 117 miles, less 30 graded,	87
	——
Carried forward.	87

Brought forward,	87	117
On the Western Division 134 miles, less 10 graded,	124	
On the Delaware Division, between Deposit and Calicoon creek, 40 miles, less 30 graded, - - - -	10	
On the Delaware and Eastern Division, between Calicoon creek and Middletown, - - - - - - -	65	
West of the Wallkill, between Goshen and Middletown,	2	
	——	288

Portions remaining to be put under Contract.

Between Binghamton and Deposit, estimated at -	38	
Between Goshen and the Wallkill, - - - - -	3	
	——	41
Total length of the road, supposing the shortest line from Binghamton to Deposit to be adopted, - - -		446

II. — OF THE EXPENDITURES AND LIABILITIES OF THE COMPANY.

The amount expended up to the close of 1838, was	$384,219.73
The expenditures in 1839, amounted to - -	306,989.79
Ditto, in 1840, to - - - - -	535,906.13
	$1,227,115.65

At the close of 1840, the liabilities of the Company for work done and for materials furnished on the road, and for iron, locomotives, cars, and other requisites, amounted to not less than $500,000, to protect which, further collections on their stock were in progress.

The amount of stock subscribed in the counties on the Susquehanna Division of the road in 1840, including previous subscriptions, which were rendered obligatory by the action of the Company in closing contracts for that Division, is estimated at on which more than $80,000 have been collected.	$ 350,000
The amount subscribed, with reference to the contracts on the Western Division, including previous subscriptions, rendered obligatory by these contracts, is estimated at - - - - - -	300,000
The amount subscribed within the same period, with reference to the construction of the road from	
Carried forward,	$ 650,040

Brought forward,	$ 650,000
Middletown to Calicoon creek, and the completion of unfinished sections on the Delaware Division, is estimated at - - - - - - -	400,000
Subscriptions in 1840, by capitalists of the highest respectability in London - - - - - -	75,000
Balances due on subscriptions in the county of Orange, which became obligatory on the contracts being closed in July 1839, for grading the road from the line of Rockland to Goshen, and which were payable as the work advanced, amounting to about - - - - - - - - -	25,000
Making - - - - - - -	$1,150,000

independently of the original subscriptions to the capital stock.

III. — OF THE ROUTE, SURVEYS AND RELATIONS OF THE ROAD.

The route is in all respects, most eligible for a work of such extent. Proceeding westwardly, from the harbor of New York, it traverses eleven counties within this State, its course being nearly midway between, and eighty to one hundred and twenty miles distant from the Erie canal, and the canals which extend westward from Philadelphia. The physical character of the country precludes the construction of any rival work within fifty miles or more on either side; while the numerous streams and valleys which are intersected, afford great advantages of access to adjacent districts on the right and left.

The road will therefore, naturally, command the travel and tonnage of a very wide and extended region, comprising twenty-five or thirty thousand square miles, and a numerous population, besides a large proportion of the travel and traffic of the lakes and western States.

The line, moreover, has the advantage on more than three quarters of the whole distance, of being laid in the valleys of rivers, and other considerable streams, as the Ramapo, the Delaware, the Susquehanna, the Chemung, the Canisteo, the Genessee, and the Allegany rivers, and their tributaries, where the grades are extremely favorable, and the soil in the valleys west of the Delaware, adapted to the use of piles.

Excepting the portions previously located, surveys of the entire line of the road have been performed within the past year, including careful and in some instances, very laborious examinations of different routes. It was the object of these surveys to improve the line as far as possible in respect to its length, grades, curvature, adaptation to the use of piles, economy of construction, and susceptibility of further amendment with reference to an additional track; the Directors having had it specially in view to establish the location where it ought to be, on supposition of the road hereafter attaining all the importance as a thoroughfare of trade and travel, which the most sanguine have anticipated for it, and at the same time to secure the construction of a single track with the utmost practicable economy.

The original survey by Judge Wright, which possessed extraordinary merit, and entitled him to the enduring gratitude and respect of the Company, exhibited a line four hundred and eighty-three miles in length; but at the same time indicated the most important points where further examinations would probably result in shortening the distance, and in securing other advantages. Between his survey in 1834, and the close of 1838, re-surveys of the whole line and of different routes on portions of it, costing in the aggregate more than $100,000, resulted in little more than a confirmation of the recommendations and suggestions contained in his Report to the Legislature.

The surveys and examinations of the last year, leave no room to doubt but that the line selected from Piermont to Deposit, one hundred and fifty-seven miles, and from Binghamton to Dunkirk, two hundred and fifty-one miles, is, taking every important consideration, present and prospective, into view, the best that can be obtained. Its length, allowing thirty-eight miles for the distance from Deposit to Binghamton, is four hundred and forty-six miles. It admits of a convenient and advantageous distribution into Divisions, to be worked respectively by locomotives adapted in weight to the ruling grades of the several portions.

Next in importance to the route and location of the road, are its relations to other avenues and sources of travel and business.

Under this head it is obvious, first to notice its relation to the city of New York, the great mart for the products of this and the western States, and of the merchandize to be transported in return, for consumption in the interior; where, from the east and south, the great lines of travel meet, and where emigrants, and other passengers from Europe, for the most part make their landing in the country. When it is considered that the road extends, by the shortest practicable line, from this city to lake Erie ; that it is designed for the transport of heavy tonnage, as well as of passengers ; that it will be open for use throughout the year ; that the plan of its construction will render it competent to any conceivable amount of business, and that passengers may with safety be transported over it from one extremity to the other, in eighteen or twenty hours ; the importance of its connexion with this metropolis, and the value of its local effects here in obviating the disadvantages of a northern climate, and rendering business as active, and supplies as cheap, in the winter as in the summer months, cannot fail to be apparent. (See appendix, *Note A.*)

It has been supposed by some, that the termination of the road on the western shore of the Hudson, about twenty miles from this city, would prove disadvantageous, at least for some five or six weeks of the winter season ; and in anticipation of such an objection, provision was made in the charter for extending the line to the city, from a point opposite to the Company's pier. Below that point however, there is seldom, even temporarily, more obstruction from ice than on the ferries opposite to the city. The present winter, owing to the quantity of ice and the occurrence of severe storms, has occasioned difficulties as formidable as are likely to occur hereafter. Nevertheless, the company's boat has regularly performed her daily trips, and by her punctuality and success, has removed all doubt, and established full confidence, of the safety and advantage of this mode of communication with the road.

The pier, which extends about 4000 feet into the Hudson, forms a safe and valuable harbor, in connection with abundant space for all the accommodations of a depot.

Proceeding westwardly, the road passes through the valley of the Ramapo, and a region of the most valuable iron ores, and divides the county of Orange into nearly equal parts. From Goshen, situate near the centre of the county, railways are proposed to Newburgh, distant about twenty miles ; to the line of New Jersey, in a southwesterly direction ; and to the north, through Kingston, Saugerties, and Catskill to Albany ; of which the two former have been chartered. Near the western boundary of Orange, the line approaches the Delaware river, and intersects the Hudson and Delaware canal, which extends from the Hudson river, near Kingston, to the Anthracite coal beds of Pennsylvania.

In the county of Delaware, a railroad is proposed from Delhi, or from Walton, to Deposit.

In Broome county, the road intersects the Chenango canal, which extends from the Erie canal at Utica to the Susquehanna river; and also the line of a proposed railway from Utica to the Susquehanna, which has been chartered and surveyed; and another from Binghamton through Cortland and Onondaga counties, to Syracuse, and thence to Lake Ontario at Oswego, which has been chartered, and which, in connection with this road, will offer the most direct and eligible route from this city to Upper Canada.

At Owego, in the county of Tioga, a connection occurs with the Ithaca and Owego railroad, which extends from the Susquehanna to Cayuga lake, by the navigation of which, it forms an important route from the Erie canal. Near Tioga point, a connection is anticipated with the North Branch canal in Pennsylvania.

In the county of Chemung, the road intersects the Chemung canal at Elmira. The same point is contemplated as the termination of a railroad, which is in part constructed, from Williamsport in Pennsylvania, a distance of about seventy-five miles. To perfect a continuous line of railways from Philadelphia to Elmira, and thence, by the road of this Company, to lake Erie, is a principal object of this road.

It is supposed by some, (who of course are not aware how much the grades have been reduced, and the line shortened, on the eastern half of this road, since the original survey,) that on the completion of such continuous line from Philadelphia to Elmira, the distance and amount of rise and fall between these two points, will be less than between Elmira and the eastern termination of this road; and that both trade and travel will therefore be diverted from this route to Philadelphia. An examination of the subject has removed all apprehension of danger from this source. The distance from Elmira to the Hudson at Piermont, supposing the most eligible line from Binghamton to Deposit to be adopted, is two hundred and fifty-two miles, and the aggregate of ascents and descents, 3820 feet. The interval between Piermont and this city is entitled to be regarded only as a ferry.

From Williamsport to Philadelphia, several routes are projected and partly constructed; of which the most direct is that by way of Sunbury, Pottsville and Reading. Of this line, one hundred and fifty-one miles are nearly finished. Its length from Philadelphia to Elmira is two hundred and fifty-eight miles, and its rise and fall 5050 feet. It is moreover encumbered with nine formidable inclined planes, on which stationary power will be required, and is therefore not eligible for general trade or passengers. The next route in point of distance, is that via the Muncy Hills, Catawissa, and Reading, of which the length is two hundred and sixty-five miles, and the rise and fall 5530 feet; of this one hundred and fifty-two miles are completed, or far advanced. The third is a modification of the last mentioned route, and passes from Williamsport to Catawissa, by the valleys of the West and North Branch, instead of crossing the Muncy Hills. It is longer than those above referred to, but has less elevation to encounter, its length being two hundred and eighty-three miles, and its rise and fall 4630 feet; one hundred and fifty-two miles are nearly finished. The only remaining route passes down the Susquehanna to Harrisburg, and thence by way of Lancaster to Philadelphia, of which the length is two hundred and seventy-eight miles, the rise and fall 4790 feet, and the portion finished, one hundred and twenty-six miles.

Each of these different routes is in the hands of four or five distinct companies, and of course subject to the disadvantages incidental to separate interests and diverse modes of superstructure and management. The first is placed out of the pale of comparison by its inclined planes. The second is thirteen miles longer, has 1710 feet more of rise and fall, and cannot, from the arrangement of its grades and curves, be worked so economically. The third is longer by thirty-one miles, and has 810 feet more of rise and fall. The fourth has an excess in length of twenty-six miles, and in rise and fall of 970 feet.

Our road therefore, in view of this brief statement, to say nothing of its uniform character and management, or of the preference due to New York as a market, can be considered in no hazard of a diversion of its business by the lines in question, while as routes both of travel and transport from Philadelphia to lake Erie, and for the conveyance of coal and of iron from the district north of Williamsport, the Pennsylvania works will be largely tributary to the productiveness of the road of this Company.

At Corning, in the county of Steuben, the railway, forty miles in length, from Blossburg in Pennsylvania, occupied chiefly in the transport of bituminous coal, terminates in the line of this road; which also, at the same place, intersects a navigable feeder of the Chemung canal. From Painted Post or Erwin, near the junction of the Canisteo with the Conhocton river, a railroadis proposed to be connected with this, extending up the valley of the Conhocton to the village of Bath, and thence to the Crooked lake.

In the county of Allegany, at Cuba, the line of the road crosses the Genessee Valley canal, which extends from the Erie canal at Rochester, to the Allegany river, a distance of one hundred and seven miles. At Hinsdale, in Cattaraugus county, this road will connect with a Railroad which has been chartered extending along the valley of the Ichua to Buffalo.

The line passing down the Olean creek, in the county of Cattaraugus, approaches the Allegany river, along the northerly side of which it extends about thirty miles. At Olean a connection will be formed with works, to be hereafter constructed, extending thirty miles up the valley of the Allegany to valuable beds of bituminous coal.

From the termination at Dunkirk, on the shore of lake Erie, a railroad has been chartered and surveyed to Buffalo, forty-two miles; and another is proposed in the opposite direction, to be extended along the Southern shore of the lake, into the State of Ohio; from the Eastern border of which State, a continuous line of railroads has been chartered, and portions of it constructed, through Ohio, Indiana, Michigan and Illinois, to the Mississippi, opposite to St. Louis, to be intersected in Illinois, by a route from the city of Cairo, at the junction of the Ohio and Mississippi.

The harbor of Dunkirk is spacious and secure. It is open earlier, and occasionally, some weeks earlier in the spring and later in the autumn than that of Buffalo. (See appendix, *Note B.*)

This brief notice of the relations of this work to those natural and artificial avenues which intersect its route, and are already open, or are confidently anticipated, may serve in some degree to indicate its probable command of business, and its high claims to the confidence of its proprietors and of the public.

An examination of a map of this and the adjoining States, will how that most of the routes of travel and transport above noticed, are intersected nearly at right angles, which sufficiently characterises them as tributaries instead of rivals. Their aggregate length is far greater than that of the main avenue. Those extending to the right will supply for distribution in the Southern, the salt, lime, gypsum, and various manufactures and products of the

Northern counties of this State; while those approaching from the South and West, will furnish for transport from numerous points, anthracite and bituminous coal, iron, and the products of agriculture and of the forest.

IV. — OF THE COST OF THE WORK.

The former estimates, as revised in 1835 and 1836, of the cost of constructing the work with a light superstructure and common plate rail, amounted to $6,000,000. In these estimates, however, land damages, depot buildings, water stations, and some other items, were omitted. Were the road, after being prepared under the contracts which have been made for grading and piling, to be finished with a superstructure like that formerly proposed, the cost would not exceed the amount above represented.

In the estimates above referred to, the cost of grading and preparing the road for the superstructure, amounted to $3,900,075. Under the contracts which have been made, and to the extent of about one-third executed, and which cover the entire line, except the section between Binghamton and Deposit, about thirty-eight or forty miles, with an estimate supposed to be liberal for that section, the cost of grading, piling, bridging, masonry, etc., to prepare the road for the superstructure, will amount to $3,840,000. The character of the work, however, which has been, and is to be, executed under these contracts, is deemed to be in some respects much superior to that contemplated in the original estimates, so as to adapt it, with an edge rail, to the use of locomotives of double the weight formerly intended, and to the conveyance of proportionately heavier loads. The masonry is accordingly more solid and permanent; the bridges are stronger, and in some instances, the grades are improved, and the line shortened, at considerable additional expense.

The adoption of piles in the construction of nearly two hundred miles of the road-way, is likewise deemed a great advantage over the ordinary method of grading. The piles used are generally of white oak, about twelve inches in diameter. They are driven by steam power, five feet apart from center to center, to such depth in all cases as to secure them from the effects of frost, and with such force as to leave them in no danger of settling under the pressure of any load. The tops of the piles being protected by timbers wide enough to cover them, it is supposed that they may endure about twelve or fifteen years. They form a road of uniformly even surface throughout the year, which is not liable to be obstructed by snow, and while they continue sound, will be subject to little or no expense for repairs. The difference between a piled and graded road for annual repairs will, it is believed, be sufficient in five or six years to defray the entire cost of renewing the piles; while the expense of working such a road, owing to the constant evenness and good condition of the rails, will be very considerably less than is commonly incurred on graded roads (See appendix, *Note C.*)

But though the preparation of the road-bed is not expected to cost more than was formerly contemplated, a very important change has been made in the plan and character of the superstructure, which will materially enhance its expense. The Directors being, after due investigation, satisfied that the ordinary plate rail and light timber formerly proposed, would be inadequate to the objects and business of this road, and in every point of view inexpedient, adopted an edge rail, of the most approved form, weighing fifty-six pounds per lineal yard, which, with the requisite chairs and spikes, will cost, delivered and distributed on the road, about $6800 per mile of single track. This rail, instead of being supported only on cross ties, laid at intervals of three to five feet, as is the case on other roads, is to be laid on heavy longitudinal sills, connected by cross-ties framed into the upper surface. These sills, by giving to the iron a continuous bearing, contribute greatly to the strength and safety of the track.

The cost of this superstructure, including all materials excepting iron, with the labor of framing and laying it down, and laying the rails, will be about $1900 per mile, making the entire cost of the rails, chairs, spikes, timber and workmanship, $8700 per mile.

Supposing the length of single track required in the first instance, with the necessary side tracks and turns-out, to be five hundred miles, the cost of iron alone, will, on the plan adopted, be $3,400,000; and of timber, workmanship, etc., $950,000, making $4,350,000, which is 74 per cent. more than was formerly allowed for the entire cost of the superstructure.

For the satisfaction of those who are not aware of the considerations which justify so enlarged an expenditure, it may be useful to refer to the experience of others on this subject.

The heaviest wrought iron rails in use in England, prior to the construction of the Liverpool and Manchester railway, were those on the Stockton and Darlington road, which weighed but twenty-eight pounds to the yard; and proved to be much too light for general traffic, and unsafe for rapid travel. Rails, therefore, weighing thirty-five pounds to the yard, were adopted; but these also proving insufficient, were removed and others of sixty-four pounds were substituted, which still remain in use.

Profiting by the experience of the last mentioned Company, the Directors of the Liverpool and Manchester road adopted in the first instance a rail of thirty-five pounds, then the heaviest which had been used in England. A single year proved its insufficiency, and it was speedily followed by one of forty-four pounds, which again gave place to a different pattern, weighing fifty pounds per yard. A very few of the latter remain at present on the road, those now in use being chiefly of four different patterns, weighing respectively sixty, sixty-two, seventy, and seventy-five pounds per yard. Experience thus induced improvements in the construction, and an increase in the weight and cost of rails, until the vast strength of the forms of section now most approved, was attained.

	Per Yard.
The rails laid on the Midland Counties road, weighed	78 lbs.
Those laid on the Eastern Counties road,	76 lbs.
Those on the London and Birmingham, the London and Southampton, and London and Brighton roads,	75 lbs.
Those on the North Eastern Counties road,	69 lbs.
Those on the North Midland, and the Manchester and Birmingham roads,	65 lbs.
Those on the Great North of England road,	62 lbs.
Those on the Great Western, now in progress,	56 lbs.

Of these, one only, is as light as that adopted for this road; and in that instance, as in ours, the rail has a continuous bearing on a longitudinal sill; while all the others are supported on chairs, at intervals of three to five feet, weighing from twenty to over thirty lbs. each.

In this country, likewise, the results of experience abundantly show, that wherever it is an object to construct a railway, it is to the last degree desirable to obtain a heavy rail. On several roads where a light bar was originally laid, it has been replaced by one better adapted safely to permit rapid travelling, to sustain the severe shocks incident to a heavy trade, and to admit of constant and economical use; of such, the Columbia, Newcastle and Frenchtown, Baltimore and Ohio, and others, might be referred to as instances.

The following statement of the cost of superstructure, with heavy rails on several roads, is extracted from a pamphlet published by B. H. Latrobe. The author does not give the actual cost in the several instances, but the calculated cost of the different plans of superstructure, at a tariff of prices, which he deems a fair average for this country.

"Baltimore and Susquehanna, - - - -	$11,556	per mile.
Stonington and Providence, - - - -	11,149	"
New Jersey, - - - - - - - -	10,700	"
Boston and Worcester, - - - - -	10,637	"
Long Island, - - - - - - - -	10,587	"
Baltimore and Ohio, - - - - -	10,354	"
Boston and Providence, - - - - -	10,352	"
Washington Branch, - - - - -	9,519	"
Philadelphia and Reading, - - - - -	9,451	"
Baltimore and Deposit, - - - - -	9,428	"
Camden and Amboy, - - - - - -	9,114	"
Wilmington and Susquehanna, - -	8,752	"
Newcastle and Frenchtown, - - -	8,736	"
Average of the above,	$10,026"	"
New York and Erie, - - - - - -	8,700	"

It was believed that with a plate rail, the road would be wholly inadequate to the travel and transport which it ought, and, if properly constructed, assuredly would command; that it would be unsafe for passengers, would be subject to enormous expense for repairs; and could not be economically used for the conveyance of tonnage; whereas, with a heavy rail, it would be competent to all its objects; could be worked with economy, would require but a moderate expense for repairs, and would be so much more productive and valuable, as to justify the confidence necessary to render it easier to accomplish its construction on the plan of an enlarged expenditure; than to carry out that originally proposed.

The cost of land and damages will be unusually small, probably not exceeding an average of $500 per mile; about three-fourths of the whole line, and suitable sites for depots being released without charge, and further gratuitous cessions being anticipated. Other donations of land having been made of the value, probably, of $1,000,000, and certainly more than sufficient to cover the cost of land for the roadway, this item is not brought into view in the following estimate of the cost of the work, viz:

For preparing the roadway for the superstructure, which includes grading, piling, masonry, bridging, fencing, and superintendence, - - - - - -	$3,840,000
For iron rails and appendages delivered and distributed,	3,400,000
For timber and workmanship for superstructure, -	950,000
For locomotives and cars sufficient for the first operations on the road, - - - - - - -	400,000
For passenger and freight depots, machine shops, water stations, engine houses, and other necessary buildings, - - - - - - -	200,000
For interest and contingencies, - - - -	210,000
	$9,000,000

In view of this estimate, which is so far founded on actual contracts, experience, and ascertained facts, as to be deemed worthy of confidence, it is apparent that further resources of capital than are yet at the disposal of the Company, will be required. The Directors rely on the stock of the Company, after large allowance for the disastrous consequences, to many of the original subscribers, of the conflagration in this city in December 1835, and the commercial revulsion of the ensuing years, for at least $3,000,000. The loan of the State heretofore granted, is of the like amount; and they trust that the progress, condition, and promise of the undertaking, will be such, before the close of the present year, as to leave no doubt of the expediency, safety, and public utility, of such further aid from the State, as the speedy completion of the work shall require.

The contracts for grading and preparing the roadway, including the superstructure of wood, on about two hundred and forty miles, require the execution of those parts of the work within two years; the payments for which, will be discharged by collections on the stock of the Company, and the proceeds of State stock yet to be received under the existing law. The further needful resources will be required for the purchase of iron. On the plan of preparing the roadway within two years, or thereabouts, it is highly desirable that the Company should be enabled to contract for the iron rails, of which about 35,000 tons are yet wanted, and for locomotives and cars, in the course of the present year, on account of the length of time required for their manufacture, and delivery on the line of the road. The importance of the entire line being put in use, and rendered productive within the shortest possible period, after the road-bed is prepared, is apparent.

(NOTE A.)

To E. Lord, Esq., President of the New York and Erie Rail Road Company :—

Sir—The subjoined statistical tables, having a bearing on matter connected with the great work of internal improvements in which you are engaged, I have prepared with much care, and respectfully submit the same for the consideration of the stockholders of your Company, and the public. Your obedient servant,

EDWIN WILLIAMS,
Compiler of the New York Annual Register.

New York, February 3d, 1841.

1—*Annual consumption of country produce in the city of New York.*

The following is an approximate estimate of the annual amount of sales of articles of country produce in the city of New York for the consumption of the inhabitants.

Fresh Beef, - - - - -	$1,470,000
" Veal, - - - - - -	365,700
" Mutton and Lamb, - - - -	335,000
" Pork, - - - - -	600,000
" Poultry, Game, Eggs, &c., -	1,000,000
Salted Beef, Pork and Hams, - -	1,200,000
Vegetables and fruit, - - - -	1,200,000
Milk, - - - - - - -	1,000,000
Butter Cheese and Lard, - -	1,500,000
Flour, Meal and other Bread Stuffs, -	3,000,000
Hay and Oats, - - -	750,000
Fuel, (Wood & Coal) exclusive of Steamboat Fuel,	2,500,000
Articles not enumerated, - - -	580,000
	$15,500,000

The above is not intended to include building materials.

The opening of a new avenue for supplying our markets, such as the New York and Erie Rail Road, which passes through a section of country well adapted to the furnishing of most of the above articles, would doubtless have the effect of reducing prices by increasing the abundance of supplies. This reduction may be safely estimated to average ten per cent. on the above amount, thus saving annually to the inhabitants of this city, a million and a half of dollars.

2—*Increase of population, &c., in the Rail Road Counties.*

Increase of population and wealth in the counties traversed by the New York and Erie Rail Road, and of adjacent counties and parts of counties in this State, as shown by the census of 1830 and 1840, and the taxed valuation of real and personal estate in the same years :—

Counties traversed.	*Census.* 1830.	*Census.* 1840.	*Value of real and personal estate.* 1830.	1840.
Rockland,	9,388	11,874	$1,696,790	$2,229,469
3-4 of Orange,	34,029	38,050	6,325,777	8,656,670
Sullivan,	12,372	15,630	1,215,750	1,319,586
3-4 of Delaware,	24,700	26,522	2,315,555	2,544,060
Broome,	17,582	22,348	1,785,168	2,361,737
Tioga,	27,704 (Tioga and Chemung)	20,350	2,398,002 (Tioga and Chemung)	1,906,747
Chemung,		20,731		3,015,592
Stuben,	33,975	45,992	1,476,340	5,787,282
Allegany,	26,218	40,920	1,260,442	5,216,000
Cattaraugus,	16,726	28,803	1,249,018	4,149,073
Chautauque,	34,657	47,641	1,851,353	4,360,179
Counties Adjacent.				
2-3 of Oswego,	34,248	32,942	3,588,730	3,879,397
Chenango,	37,404	40,779	3,481,314	4,293,438
Cortland,	23,693	24,605	2,169,119	2,320,720
Tompkins.	36,545	38,113	2,726,596	4,360,673
1-3 of Cayuga,	15,982	16,787	1,384,711	4,170,885
1-3 of Seneca,	7,010	8,289	1,008,043	1,726,318
1-2 of Yates,	9,504	10,221	1,020,348	3,231,091
1-4 of Ontario,	10,042	10,875	1,945,088	3,464,312
1-2 of Livingston,	13,859	17,855	1,712,366	5,072,979
1-2 of Gennesee,	25,996	29,820	2,149,297	6,462,772
1-4 of Erie	8,928	15,538	724,781	3,471,378
	460,562	564,685	$43,484,588	$84,000,358
		460,562		43,484,588
Increase in 10 years,		104,123		$40,515,770

3—TABLES SHOWING THE EFFECT OF INTERNAL IMPROVEMENTS ON THE VALUE OF PROPERTY IN THE CITY OF NEW YORK.

1—*Chronological Table of the Assessed Value of Real and Personal Estate in the city of New York, during three Commercial Periods :*

1st *Period*—From the close of the last war with Great Britain to the completion of the Erie Canal :

Year.	*Assessed Valuation.*	*Year.*	*Assessed Valuation.*
1815,	$81,636,042	1820,	$69,539,753
1816,	82,074,200	1821,	68,285,070
1817,	78,895,735	1822,	71,289,144
1818,	80,245,091	1823,	70,940,820
1819,	79,113,061	1824,	83,075,676

2d *Period*—From the opening of the Erie Canal, in 1825, to the completion of the Ohio Canal:

1825,	$101,160,046	1829,	$112,526,016
1826,	107,477,781	1830,	125,288,518
1827,	112,211,926	1831,	139,280,214
1828,	114,019,533	1832,	146,302,618

3d *Period*—From the completion of the Ohio Canal, in 1832, to the present time:

1833,	$166,495,187	1837,	$263,747,350
1834,	186,548,511	1838,	264,152,941
1835,	218,723,703	1839,	266,882,430
1836,	309,500,920	1840,	252,135,515

N. B. During the latter period, namely, since 1832, about 470 miles of Rail Road have been completed and put in operation in this State, besides about 2,500 miles of Rail Roads in other States. Thus it will appear that since the introduction of the *Rail Road System*, the value of real and personal property in the city of New York has increased over *one hundred millions of dollars.*

The amount of tonnage of Canal boats passing and repassing Utica, on the Erie Canal, for one year, it is ascertained, is greater than that of all the foreign and domestic shipping entering and clearing at the port of New York. *(See R. R. J. Vol. 4, No. 1.)*

2.—*Chronological Table of the Assessed Value of Real Estate only, in the city of New York, for a series of years:*

Year.	*Real Estate.*
1817,	$57,799,435
1820,	52,062,858
1823,	50,184,229
1825,	58,425,395
1828,	77,139,880
1831,	95,716,485
1833,	114,124,566
1834,	123,249,280
1836,	233,742,303
1839,	196,940,134
1840,	187,121,714

Increase of value of real estate in this city, since 1831, over 91 millions of dollars.

Assessed value of personal estate in 1840,	$65,013,801
" " " 1833,	52,366,976
Increase,	$12,646,825

Extract from a report to the stockholders of the Camden and Amboy Railroad Company, dated January 29th, 1840:—

"Two years since, at the request of some market people in New Jersey, a line called the Pea Line, with two cars, was occasionally started from Camden to New York, with no other view or expectation than the accommodation of a very useful and respectable class of men. This line has steadily increased, until it has become profitable beyond all expectation. During the past year, it has been running daily, sometimes taking with it as many as sixteen cars, laden at the appropriate season with Peas, Peaches, Potatoes, Asparagus, Cabbages, Live Stock; and upon one occasion, (incredible as it may seem) thirty tons of Green Corn. This, connected with the gradual increase on the other lines, will enable you to judge what you may fairly expect in a few years hence; always bearing in mind, that the expenses do not increase in the same ratio with the receipts, because the same capital can do a larger business, whilst the interest to be paid remains the same."

(NOTE B.)

DUNKIRK HARBOR.

Extract from the documents accompanying the President's Message to Congress, of December, 1837.

"The importance of the harbor of Dunkirk, in a commercial point of view, has heretofore been fully set forth. The surface enclosed by the government works, will be about two hundred and eighty acres, of which there are eighty acres of excellent anchorage, with clay bottom; and there is wharf room sufficient for the transaction of a very large business. It occupies a position nearly midway between Buffalo and Erie. It is extremely valuable as a port of refuge, and has been much resorted to for that purpose by steamboats and sail vessels; and it has been selected for the termination of the New York and Erie Railroad through the southern tier of counties of the State of New York; a work, the completion of which will at once place it among the chief harbors on the shores of lake Erie. The number of steamboats and sail vessels touching at this port has, during the past season, greatly increased. From the opening of the navigation, on the 5th May, to the 30th September, 1837, the number of arrivals of steamboats was 630, whose probable tonnage amounted to 183,177 tons, and the number of passengers to 78,700. During the same period, the number of arrivals of sloops and schooners was 103. Shipping to the amount of 778 tons is owned at the port."

The above is taken from the annual report of T. S. Brown, *General Superintendent of the U. S. works at the east end of lake Erie.*

The distance from Dunkirk to Piermont, on the Hudson river, by the line of the New York and Erie Railroad, is 446 miles. Including the *ferry*, the whole distance to New York city does not exceed 468 miles.

From Buffalo, by the way of Albany, to New York, the distance by railroad will be about the same, viz :—

Buffalo and Batavia Railroad, (via. Attica,)	39	miles.
Batavia and Rochester " - - - -	32	"
Rochester and Auburn " - - - -	78	"
Auburn and Syracuse " - - - -	26	"
Syracuse and Utica " - - - -	54	"
Utica and Schenectady " - - - -	78	"
Schenectady and Albany " - - - -	16	"
Albany and New York " - - - -	149	"
Total, - - - -	472	miles.

Dunkirk is 42 miles west of Buffalo, on the south shore of lake Erie, and its harbor is occasionally open many days, and even weeks, earlier in the spring and later in the fall.

The line of the New York and Erie Railroad being entirely in the hands of one Company, the principle of charging less per mile in proportion as the distance travelled is greater, may be brought into action, and will, doubtless, result in great advantage both to the public and to the Company. Passengers from Dunkirk to New York city, for instance, may be charged 12 dollars, which will be about $2\frac{1}{2}$ cents per mile ; whereas, way passengers travelling 100 miles or less, may be charged 4 cents per mile. As the superstructure will be heavy and substantial, passengers by quick trains may with certainty and safety go from Dunkirk to New York in from 20 to 24 hours, or at the average speed of 20 miles an hour, including stops.

If we compare this with the state of things at present existing on the northern line, and which will probably continue for a considerable time to come, we shall see that there, in consequence of there being eight different corporations, each of which, until compelled by some strong inducement to the contrary, will charge the full rate of 4 cents per mile, the price of the passage from Buffalo to New York will be from 17 to 19 dollars,—the former sum allowing for a deduction by the competition of the North river steamboats. As the track on the northern line consists of the light plate bar, the speed cnanot exceed 15 miles per hour; and the time occupied, including the unavoidable detentions resulting from so many different proprietorships, the ferry at Albany, etc., cannot be less than 36 hours. The New York and Erie Railroad, therefore, at the first commencement of its operations, may very well be able to offer to passengers from lake Erie and the western States, the inducement of a saving of five dollars in expense, and twelve hours in time.

(NOTE C.)

Description of the manner in which it is proposed to construct the track of the New York and Erie Railroad, on those portions not already laid. The part between Goshen and Piermont has been made on the same principles, with some modification of the details.

The Iron Rails are of the H form, with heavy heads. They are $3\frac{1}{2}$ inches high, 4 inches wide on the base, and weigh 56 lbs. per lineal yard. Both sides are alike, in order to admit of reversion, if symptoms of failure are perceived in those parts exposed to the action of the wheels.

The rails are to be supported on continuous bearings of timber, twelve inches broad eight inches thick, and as long as can be conveniently obtained. They must be scraphed at the ends, so that no irregular elevation or depression of either stick can take place at a joint. They will break joints with each other, and with the iron rails; and will be bound together, at every six feet on curves, and at every eight feet on tangents, by cross ties of plank, seven and a half feet long, three inches thick, and seven inches wide, fitted accurately into notches two and a half inches deep, on the upper side of the longitudinal timbers, and secured by a treenail, or pin of oak, two inches in diameter. The position of the base of the rail having been then accurately marked out on the cross ties, notches half an inch deep and four inches wide will be cut in them, so as to let the rail rest continuously on the longitudinal timbers, the edges of which must be addiced down to shed the rain.

The rails are secured from any motion, except that due to the expansion and contraction of the metal, by appropriate chairs of cast iron at the joints; and are fastened to the timbers by brad headed spikes, half an inch square and five and a half inches long, one of which is required for every eighteen inches.

Where timber of suitable quality is found on the line of the road, it may be hewn on two sides instead of being sawed square. In such cases it must be got out nine inches thick, and counter hewn on the upper surface before being laid.

It will be noticed that by this plan of road, each bearing timber rests continuously on the ground, and at the same time supports continuously the iron rail. The cross ties too, have a double action; binding together the longitudinal bearers, and also connecting the rails, by the notches into which their bases are fitted. By placing the ties on the upper side of the bearers instead of the lower, the connexion is made at the point where its efficiency is greatest and most necessary, and as no part of the vertical support is derived from the ties, the dimensions proposed for them will be found sufficient.

The drainage of the track will be effected by a ditch between the longitudinal timbers, for which the width between the rails affords ample room; and cross drains at suitable distances will carry off the water. The centre drain, will be sunk lower than the cross ties, so as not to interfere with them.

The following extract from an English writer, Mr. John Reynolds, explains very satisfactorily the disadvantages of the ordinary modes of constructing railways, and accounts in some measure for the great weight which the latest patrerns of British rails exhibit.

"The principle of continuous bearings, avoids the chief obstacle to durability, which pertains to the plan of supports at intervals, whether they be blocks or sleepers, viz. the alternation of *flexible spaces* and *rigid points*, which, (even if the supports maintain an exact level,) produces in carriages moving rapidly over them, a series of concussions, as the wheels successively impinge on the rigid or supported parts of the rails. Also, however small may be the deflexion of the rail between its points of support, those points become fulcra, on which it acts as a lever, to raise or shake the supports next beyond them. When the supports assume irregular heights, (which is the usual case,) not only are the above evils greatly aggravated, but the rail acts upon every support as a spring beam, tending to jerk it up, or loosen its fastenings."

Where a *piled road* is adopted, (which will be the case on more than two hundred miles of the Susquehanna and Western Divisions,) a similar superstructure is proposed, with the necessary modifications for connecting it firmly and securely to the heads of the piles.

The *width of track* on the New York and Erie Railroad is six feet, and the distance between the tracks (where two lines are laid,) is seven feet. These dimensions admit of wider and more commodious cars being used with safety, than can be adopted for roads of the ordinary width. The first class passenger cars already built for this road, are believed to be equal to any hitherto constructed in the United States, with regard to beauty and finish, and superior in all the arrangements and appliances requisite for comfort and ease. They are eleven feet wide, and thirty-six feet long, and are mounted on eight wheels. Those intended for gentlemen, will accommodate comfortably seventy-eight persons. The ladies' cars have drawing and retiring rooms of ample dimensions.

The second class cars, intended for the use of emigrants, and others desirous of travelling at a low rate, and willing to accept of cheaper accommodations, will be capable of carrying one hundred persons.

(To be continued.)

New Locomotive.—Mr. Ross Winans of Baltimore, has completed a locomotive engine of great power. The engine has been constructed with a veiw to adapting it to the purpose of transportation. Its weight, when in running condition, is nineteen and a third tons, equally distributed on eight wheels, all which are driving or propelling wheels; hence the adhession of the entire weight of the machine is made subservient to its tractive power. The boiler, of the upright description with vertical tubes, is peculiarly adapted to the use of coal, has 650 tubes and 20 square feet of fire grate. The cylinders are 14 inches in diameter and 24 inch sroke.

Franklin Railroad.—The Hagerstown Torchlight states that the section of the above road between the Pennsylvania State Line and Hagerstown is completed, and the cars commenced running upon it on Wednesday. The occasion was duly celebrated by the citizens of Chambersburg and Hagerstown.—*Baltimore American.*

Quicker Yet.—The new Locomotive, "Owasco," with one passenger car, went from Auburn and Syracuse on Thursday last, distance 26 miles, in 52 minutes. This is the quickest trip ever made on the road. The engine was built by Messrs. Dennis, Thomas and Wood of this place, and is superior as a peice of perfect mechanism to any thing we ever have seen.

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 5, Vol. VI.
New Series. | MARCH 1, 1841. | Whole No. 377.
Vol. XII.

We are again indebted to our esteemed friend, Joseph E. Bloomfield, Esq. for two valuable communications. One is an abstract of the Annual Report of the Railroads in Massachusetts, accompanied by the tabular arrangement of their statistics, in continuation of the series which Mr. B. has prepared for our Journal for several years past. The value of these tables is shown by the frequency with which they are quoted—not always with the proper acknowledgment of the source whence they are derived.

We would request attention to the formula proposed by Mr. B. for the proper distribution of the several items of expense, for want of which, many reports are greatly curtailed in their usefulness. We shall always cheerfully give place to any such statistics when furnished.

The other communication is an abstract of a report made to the legislature by the Utica and Schenectady Railroad Company, and furnishes interesting data—as coming from a road devoted entirely to the transport of passengers.

In furnishing these articles, Mr. Bloomfield has added another to the many obligations of a similar nature which have so often placed us in his debt, and has also set an example which is worthy of being followed.

To the Editors of the American Railroad Journal and Mechanics' Magazine.

I continue at your request, the tables of preceding years, presenting the receipts, expenses, and dividends, on the several railroads of Massachusetts in use, to 1st January, 1841.

To make it more acceptable, and to arrive at thefollowing results, I have introduced the receipts and expenses, for four years of the three principal roads, the longest in use.

It will be perceived, that Massachusetts has completed	
329½ miles of railroad, at a cost of	$12,111,136
62½ miles from Springfield to West Stockbridge, is estimated to cost, complete,	3,218,056
38⅓ miles from the State line, to Albany, being the continuation of the western railroad—es-estimated,	1,412,804
430 will cost,	16,742,006
In addition to the above, there has been expended on the Boston and Portland railroad,	523,091
Total,	7,265,097

The line of road from Boston, via, Worcester, Springfield and West Stockbridge to Albany, with a distance of 200 miles, is estimated to cost $8,582,530, and to be completed in 1842. With all its fixtures for a *freighting business*, it will cost $9000,000—or $45,000 per mile for a single track.

The average nett earnings of the three principal roads, to wit, the Boston and Lowell, the Worcester and the Providence, railroads, for the last four years, have equalled eight per cent, with a yearly surplus to renew their superstructures.

During the construction of these railways not a dollar has been expended by the State, or individuals, on a new canal in Massachusetts, while those great works—in their day—the Middlesex and the Blackstone canals, have nearly fallen into disuse. The Hampden and Farmington canal, in Connecticut, has not received tolls sufficient to keep itself in repair. It is now proposed, to turn its bed into a railroad, to prevent a total loss to its stockholders. The extension of the New Haven railroad to Sptingfield, parallel to it, is expected to entirely supercede it.

It is to be regretted, by the friends of railways, that the officiel annual reports, from which the annexed table is constructed, are not classed with more order, for the benefit of the railway system.

The repairs, and expense of running the *engines*, with their number on each road, should be kept separate from the coaches, and the cars—these again should be divided,—the items of fuel, oil, wages for *engine drivers* and brakemen—salaries of agents, office and incidental expenses, should be so arranged, as to arrive at the cost of *motive power*, per mile, to operate the road, for freight as well as for passengers. The report should state the number of *way* and *through* passengers:—the tons of goods carried,—the rate for freight and passengers per mile, with the whole distance run by the engines. In the infancy of our railroad management, we would do well to follow the English plan on this subject, and *report them in tabular form to the Railroad Journal.*

The following results taken from the table, may be interesting to other roads for comparison.

The average cost of repairs, to *both* engine and cars, on all the roads, per mile, per annum, is $438
Ditto, of the road, (a large portion just finishəd,) 384
Ditto (exclusive of the *western railroad,* which road is only in part opened, and should not be introduced into the calculation the repairs for engines and cars,) on the other roads will then be found to be, per mile, per annum, 540
Ditto, for repairs to road-bed and superstructure, 474
Ditto for oil, fuel, wages and incidental expenses, 1742
The total average of annual expenses per mile, per anuum, of all the railroads in operation in Massachusetts. 2785

This average expense per mile, per annum, is high compared with the Utica and Schenectada railroad, which is $1408. This sum, is the average per annum of the expenses on that road for four years and 5 months, for 78 miles, 22 miles of which, is a double track.

It will be perceived, that it has cost in Massachusetts $1,732,353
To receive from freight, mails and passengers 3,634,980
From freight and the mails, received 1,248,874
From passengers there has been received 2,386,106

The expences are 47 per cent, of the receipts. The freight, compared with passengers, is as 1 to 2.

The percentage of increase of freight, on the *Boston and Lowell* railroad, is yearly 20 per cent. for four years. On passengers, only 3 per cent. per annum.

The receipts for 1840—on the *Boston and Providence* railroad, fell off $48,281, compared with 1837, whilst the *Boston and Worcester* railroad, during the same period, increased from $210,047, to 267, 547, the increase, $57,500, being from passengers. This is to be attributed to the extension of the *Western* railroad $54\frac{1}{2}$ miles to Springfield—and the opening of the *Norwich and Worcester* railroad 58 miles. The increase from passengers on the *Boston and Providence* railroad, in 1837, $193,469, compared with the last year, $134,331; shows that the receipts on the *Boston and Worcester* railroad is entirely from passengers from the Providence railroad. It should be taken into consideration, that last year, was one of unusual dullness for trade and travel. The first opening of the Norwich and Worcester road from its novelty, no doubt, increased the travel over it, to the prejudice of the Providence railroad. *Low fares*, and *quick time*, will get it back.

The increase of receipts on the *Eastern* railroad, at the test of "*low fares*," was 50 per cent. both on freight ana passengers. On the *Taunton Branch*, the increase on freight the last year, compared with 1839 was 78 per cent. On the *Nashua and Lowell* railroad, during the same period, the increase on freight (its main support,) was 150 per cent, whilst its receipts for passengers, fell off 3 per cent. These three last named roads have been in operation only three years; although *short roads*, they appear to have yielded their stock holders 6 to 7 per cent from their commencement. Cotton, flour, tobacco, and *bulky articles, of every description*, are carried over these roads, at cheap rates. The rates will gradually be reduced by competition, and the introduction of more capital, to purchase improved engines, to carry freight at reduced cost for *motive power*.

An instance is presented, from the receipts on the *Grand Junction Railway*, in England, for the last six months, of 1839 compared with 1840.

Six months, 1839.		*Six months*, 1840.	
Receipt from coaches,	£187,476	Receipt from coaches,	£188,620
do. Goods,	35,220	do. Goods,	40,934
do. Live stock,	3,607	do. Live stock,	3,008,
	226,304		232,563
Expenses,	107,880	Expenses,	99,627

Nine thousand pounds was saved, in the *motive power*, while the receipts were increased £14,512 during the same period.—On the Utica and Schenectady railroad, the expenses for locomotive

engines in 1837, to carry 139,000 in passengers, was	$13,315
In 1840, to carry 174,441 passengers,	9,164
Fuel for engines, offices, shops, 1837,	36,853
do do. 1840,	18,933

Many other examples could be quoted. Experience is gradually reducing our expenses. It is ascertained, that on lines where there is a sufficient *passenger business* to pay the expenses and interest on the cost of the road, that with a small addition of capital in motive power, railways can transport cheaper than canals, both being free of toll, and taxes. This will be the result, on the line of the Erie canal so soon as there is a track, with a good edge rail, from Albany to Buffalo. Respectfully,

Jos. E. Bloomfield.

TABLE OF THE COST, RECEIPTS, EXPENSES, INCOME AND DIVIDENDS, OF THE RAILROADS IN USE IN MASSACHUSETTS: *Compiled from the Annual Reports to the Legislature, of* 1841, *made by the several Corporations, under oath.*

—A L S O—

A *comparative view, of the Boston and Lowell—The* Providence *and the Worcester Railways, for the years,* 1837, 1838, 1839 *and* 1840, *inclusive.* By J. E. Bloomfield.

Name of Road.		Length.	Expended in cost of road.	Cost of road per mile.	Rep'rs of engines and cars.	Rep'rs of road.	Rep'rs en'gs & cars per mile.	Rep'rs of road per mile.	Fuel, oil, salaries and incidental expens's	Total expens's	Total Receipts	Income from passengers.	Income from freight and the mail.	Dividends per ann.	Remarks.
Boston and Lowell,	1837				16,633	14,056	650	546	33,424	78,508	180,77[illegible]	117,643	63,137	7	Double track.
Do.	1838				10,945	15,734	421	611	48,917	75,597	191,78[illegible]	109,083	82,697	7	
Do.	1839				16,384	18,843	636	731	56,923	92,151	241,220	135,037	106,131	8	
Do.	1840	25¾	1,729,242	63,000	14,455	21,013	561	816	55,932	91,400	231,575	127,008	104,567	8	
Boston and Providence,	1887				29,794	11,707	726	285	114,737	156,238	250,[illegible]82	193,469	57,413	8	Single track, with turn-outs.
Do.	1838				19,953	16,856	486	411	83,234	120,044	2[illegible]5,114	196,974	68,140	8	
Do.	1839				19,467	8,604	474	209	65,491	93,562	313,907	234,237	79,670	8	
Do.	1840	41	1,782,000	43,460	16,765	13,281	409	334	7[illegible],413	143,127	202,601	134,651	67,949	7	
Boston and Worcester,	1837				20,053	9,185	450	206	65,524	94,762	210,047	123,331	86,716	7½	* In 1840, two new bridges built, sleepers removed, depot purchased.
Do.	1838				15,672	12,521	349	281	4[illegible],534	85,572	212,324	112,032	100,292	7½	
Do.	1839				25,198	18,035	564	405	83,[illegible]51	126,384	231,807	122,496	109,311	6	
Do.	*1840	44½	1,934,981	43,300	1[illegible],667	40,731	374	8[illegible]0	83,043	140,441	2[illegible]7,547	170,855	96,692	6	
Lowell and Nashua,	1839				2,273	3,949	156	272	23,663	29,885	55,053	36,647	18,406	6½	
Do.	1740	14¾	368,703	25,400	4,737	3,447	332	243	24,763	52,532	82,638	35,794	46,849	7½	
Eastern, incomplete,	1839				8,563	6,527	214	163	38,084	53,174	125,623	113,068	12,564	5	
Do.	1840	60	1,864,190	31,000	12,916	7,909	616	316	64,968	85,793	183,296	164,971	18,326	5	Incomplete.
Taunton Branch,	1839				3,152	1,397	287	127	3[illegible],161	40,711	58,018	40,910	17,108	7	
Do.	1840	11	250,000	22,791	1,714	2,609	156	237	40,348	4[illegible],67[illegible]	75,477	44,900	30,577	6	
New Bedford and Taunton,	1840	11¼	387,500	34,450	1,318	2,565	120	233	9,1[illegible]2	1[illegible],02[illegible]	26,437	23,250	3,186	6	Just completed,
Norwich and Worcester,	1840	58½	1,777,471	30,380	—	—	—	—	—	52,503	116,617	78,900	37,617		Just completed,
Western, incomplete,	1840	117	5,235,025	44,470	6,289	10,289	119	161	4[illegible],501	62,0[illegible]	112,347	70,821	41,526		Do. fm Wo'str to Sp'gfl'd op'd 1842
Total,		383¾	15,329,192	40,024	272,728	239,258	438	384	1,093,973	1,732,353	3,634,980	2,386,106	1,248,874		

For the American Railroad Journal and Mechanics' Magazine.

UTICA AND SCHENECTADY RAILROAD.

The report of this important *passenger railroad*, in answer to a resolution of the assembly of the 5th of February, is replete with practical information. It is highly desirable, that all railway companies imitate the example, of stating the repairs and expenses of running the engines, separate from repairs to both coaches, and cars. These two items, should be separate, where there is a mixed business of freighting, and passengers. This is necessary to arrive at the cost of transporting a passenger, as well as of a ton of goods, a mile.

The report is defective, in not giving the number of engines, coaches and cars, in use on the road, as well as the number of miles run by each locomotive, with the separate, and aggregate repairs to each. It is understood the engines are eight, of eight tons, from Baldwin's factory, of the 2d class, the cars, about 45.

In a former report, the distance from Schenectady, to Utica is stated at 78 miles with 22 miles of turn outs—twenty miles are in the centre of the road, making 100 of single track. The entire cost of this road "for roadway, fencing, grading, and superstructure, buildings and other fixtures, engines and coaches, and all other charges, incidental to construction account, as well as the purchase of the Mohawk turnpike, from the commencement of the preliminary survey, on the road, September 1833 to December 31, 1840, is $1,901,785,21

The capital stock of the company is	2,000,000,00
There has been paid, in capital dividends,	1,800,000
The amount of *dividends* made and paid since February 1, 1837, to December 31, 1840, has been	917,000
The amount received for the *transportation of passengers* from August 2, 1836, to December 31, 1840, is	1,497,640
For the mail and other items,	$121,000

The number of *through passengers* carried per each year during 4 years and 5 months, is as follows:

1836	1837	1838	1839	1840	Total.
45,391½	79,095½	82,459	95,776½	86,823½	389,547
Way Paseengers.					
30,224½	59,854	71,001½	86,823	86,619½	334,522

By a table in the report,of the ordinary expenses of the road, from which we derive the following results, it will be perceived, that it cost $551,958,23, to transport 724,069 through and way passengers, for which $1,618,640 was received. The expenses of the road is 33 per cent. on the receipts. This is an instacne of a well managed railroad. It reflects great credit on the superintendant, Mr. Young, who deserves the salary of $5000 per annum, which we perceive is allowed, by the liberality of an intelligent board of directors.

The average expenses per mile, per annum, calling the length of road 100 miles, is the very moderate sum of $1248, or $1408 per mile, for 78 miles.

Of this, the expense for locomotive engines is		192	per mile.
"	Repairs of locomotive engines,	95	"
"	Repairs of coaches and cars,	60	"
"	Oil for engines coaches, machinery, etc.	32	"
"	Fuel,	243	"
"	Maintenance of ways and fixtures	303	"

It should be taken into consideration, that this road has a light, flat iron bar. The cost per mile, after deducting the cost of right of way, and cost of Mohawk turnpike is about $18,000. The *right of way*, about $5000 per mile.

Six of the principal railroads in Massachusetts, 161 miles in length, at the average cost of $44,000 per mile, in part with double tracks, received in 1839, for passengers $682,385, and for freight $343,190,=$1,025,628. The total expenses, to receive this sum was 435,867, or 43 per cent. The average of the last four years, is 47 per cent.

There is a striking fact presented by the report of the Utica and Schenectady railroad, to wit, the fare of the road for the 78 miles is $3 for each through passenger, and the way passengers about in the same proportion. The receipts from the *through* passengers is $1,168,641 or nearly in the proportion of three to one for *way* $328,999. It should be noted, that the Erie canal, with packet boats and the Mohawk and Turnpike run parallel with the railroad. The railroad is not permitted to carry extra baggage, unless free, nor goods except in the winter, and charged with canal tolls!!!

It is to be hoped that this restriction on commerce, will be done away with, and that individual enterprise will be permitted to compete with the present State monopoly of transportation on the Erie canal, or that *the enlargement will be abandoned.*

J. E. Bloomfield.

For the American Railroad Journal and Mechanics' Magazine.

ESTIMATE OF COST OF MOTIVE POWER.

Annual cost of maintaining an engine, supposing the same in operation and running at the rate of 100 miles per day, or 10 hours at 10 miles per hour, estimating 300 days to the year.

Cost of engine $7000 interest on which 6 per cent, is	$420 00
Expense of repairs and renewal,	1000 00
Services of engineer 313 days—2. 50 per day,	782 50
do assistant do and fireman do—1. 50 per day,	479 50
Fuel 100×300=30,000 miles, $2\frac{1}{2}$ cords per 100 miles=1050 cords at $4,	4200 00
Oil, &c.,	200 00
Total annual expense of engine,	$7,082 00

The above engine will carry a gross load of 300 tons upon a level, or 200 tons from Buffalo to Albany, on ground, if any thing, less favorable than that on which the Erie canal is located or the road from New York to Albany—200 tons gross is about equal to 140 tons nett, to convey which will require 40 freight cars.

40 cars at $300 is $12,000—interest at 6 per cent is	$720 00
renewal and repairs of 40 cars at $60	2400 00
oil, &c.,	300 00
5 brakemen 313 days=1565 days at $1,	1565 00
Total annual expense of 40 cars,	$4985 00
Expense of engine as above,	7082 00
Amount required to convey 140 tons 300×100=30,000 miles or one ton 4,200,000 miles	$12067 00

Which gives for the conveyance of one ton, 1 mile $2\frac{7}{8}$ mills

Supposing the engine and train to run one half the distance without load, the cost is $5\frac{3}{4}$ mills per ton per mile—and adding 20 per cent for supernumerary cars and engines, amounts to $6\frac{9}{10}$ mills per ton, per mile.

The Railroad from Havana to Gumes, on the Island of Cuba, produced in 1839 a total revenue of $307,878, viz: $171,825 from passengers, and $136,053 from freight. In the year 1840 the income from passengers was $172,436; freight, $172,836. Total, $345,272. Increase of revenue from 1839, $37,394.

Illinois and Michigan Canal.—The Fifth Annual Report of the Canal Commissioners of Illinois, states that the expense already incurred on this work is $4,073,480 09

The estimated cost of the Canal,	8,480,478 68
Amount remaining to be done,	$4,447,430 58

Which is supposed can be completed in three years if there is no impediment from the want of funds.

SECOND REPORT OF THE DIRECTORS OF THE NEW YORK AND ERIE RAILROAD COMPANY, TO THE STOCKHOLDERS.—*February* 3*d*, 1841.

(Continued from page 128.)

V.—OF THE PROBABLE INCOME OF THE ROAD.

Instead of proposing simply an estimate of the probable number of passengers on this road, connected as it is, at its extremities, with the greatest sources and facilities of travel in the country, and throughout its whole extent, with tributaries from the right and left, or of the quantity of tonnage it may command, it seems appropriate to observe, that it occupies a route which is exempt from all hazard of competition; that it will accommodate an extent of country far larger than that which supplies the business of the Erie canal; that it is adapted to the object of tonnage as well as to that of travel; that besides the ordinary products of agriculture and manufactures, it will have large resources of business in the transport of minerals and lumber; and that the population within such distance of it, as to be relied on for its support, will not be less numerous than that which contributes to the tolls, freight and travel, on the Erie canal, and the works near its borders.

To illustrate the consideration last above mentioned, the following statements are submitted in the belief that the results will justify the utmost confidence in the productiveness and value of the work.

Statement of the population, by the census of 1840, of the counties traversed by the road, and of adjacent counties, and parts of counties, to which it will be the most convenient route of communication with the city of New York.

COUNTIES THROUGH WHICH THE LINE EXTENDS.

Rockland,	11,874	
Orange,	50,733	
Sullivan,	15,630	
Delaware,	35,363	
Broome,	22,348	
Tioga,	20,350	
Chemung,	20,731	
Steuben,	45,992	
Allegany,	40,920	
Cattaraugus,	28,803	
Chautauque,	47,641	
		340,385

ADJACENT COUNTIES IN THE STATE OF NEW YORK.

Two-thirds of Otsego, - - - - -	44,248	
Chenango, - - - - - - - - -	40,778	
Cortland, - - - - - - - - -	24,605	
Tompkins, - - - - - - - - -	38,113	
One-third of Cayuga, - - - - - -	16,787	
One-third of Seneca, - - - - -	8,289	
Yates, - - - - - - - - -	20,442	
One-quarter of Ontario, - - - - -	10,875	
One-half of Livingston, - - - - -	17,855	
One-half of Genesee, - - - - -	28,305	
One-quarter of Erie, - - - - - -	15,788	
		266,085
		606,470
Adjacent border counties of Pennsylvania, viz: Erie, Warren, McKean, Potter, Tioga, Bradford, Susquehanna, Luzerne, Wayne, and Pike, and parts of some others; and in New Jersey, parts of Sussex, Passaic, and Bergen, estimated at - - - - - -		230,000
		836,470
Under the influence of the construction and use of the road, the increase in the above counties, in the next five years, may be safely estimated at 20 per cent., or		167,294
		1,003,764

The foregoing statement is made with reference to the state of things when the road is completed, and comprises considerable numbers within this State, which at present contribute to the support of the Erie canal, through the Chenango and Chemung canals, and by various land routes; for all which there is room for adequate allowance in the ensuing calculations.

By the census of 1830, it appears that the number of inhabitants in the above mentioned counties, and parts of counties, in this State was - - - - -	477,823
Increase in ten years, 27 per cent., or - - - -	128,647
	606,470

The increase in the State at large, during the same period, excluding the city of New York, was 23¼ per cent.; and in the city of New York, 50½ per cent.

In the eleven counties traversed by the road, the number of inhabitants in 1830, was - - - - -	262,433
Increase in ten years, 30 per cent., or - - - -	77,952
	340,385

The number of acres of land taxed in the aforesaid counties, and parts of counties, in this State in 1839, was	8,781,765

The number of acres taxed in the canal counties, and parts of counties, represented in the following statement, was, in 1839, - - - - - -	6,631,955

Statement of the population in 1840, of the counties which are traversed by, and other counties and parts of counties, which now are, and will, it is assumed, continue after the road is completed, to be tributary to the Erie canal.

Schenectady, - - - - - - -	17,233	
One-third of Otsego, - - - -	17,124	
Montgomery and Fulton, - - -	43,839	
Herkimer, - - - - - - -	37,378	
Oneida, - - - - - - - -	85,327	
Madison, - - - - - - -	40,067	
Oswego, - - - - - - - -	43,820	
Onondaga, - - - - - - -	67,914	
Two-thirds of Cayuga, - - - -	33,575	
Two-thirds of Seneca, - - - -	16,579	
Wayne, - - - - - - - -	42,160	
Three-fourths of Ontario, - - -	31,876	
Monroe, - - - - - - - -	51,912	
One-half of Livingston, - - - -	17,855	
Orleans, - - - - - - - -	25,015	
One-half of Genesee, - - - -	28,305	
Niagara, - - - - - - - -	31,114	
Three-fourths of Erie, - - - -	46,615	
		677,708
The number in the same counties, and parts of counties, in 1830, was - - - - - - - - -		548,205
And in 1835, the number was - - - - -		646,197

Increase in ten years, from 1830 to 1840, 23½ per cent.
Increase in five years, from 1835 to 1840, 5 per cent.
With an increase of 5 per cent. in the next five years, the number will be - - - - - - - - 711,593

If to 677,708 be added the inhabitants of the city and vicinity of Albany, say 32,292, making 710,000, an increase of 7 per cent. thereon in five years, will make an aggregate, in round numbers, of 750,000.

The very moderate increase above noticed, of 5 per cent., between 1835 and 1840, is most probably to be accounted for, by supposing that the effect of the canal in drawing population within reach of its facilities, and in enhancing the price of farm lands from four or five, to fifty, eighty, or an hundred dollars per acre, according to position, had been realized prior to 1835; while the extraordinary increase of 30 per cent. in ten years in the counties on the line of the road, indicates that the anticipation of that work, added to the very low price of lands in those counties, had induced emigration thither.

If to the population to be immediately accommodated by the railroad, as above stated, viz: - - - -	836,470
be added that of the city of New York, in 1840, viz:	312,832
and that of Brooklyn and vicinity, say - -	45,718
The aggregate will be - - - - - - - -	1,195,010

The increase of which, in the next five years, supposing the road to be completed and in full operation within that period, may be safely estimated at 25 per cent., making, in round numbers, - - - - - 1,500,000

It is, therefore, abundantly manifest that a population not less, but more numerous than that by which the canal and its route is used, is to be accommodated, and relied on for the support of this road.

Now the tolls annually collected on the Erie canal and its branches, exclusive of the Champlain canal, amount in round numbers, to $1,500,000

The cost of freight on the canal, is at least three times as much as the tolls, or - - - - - - 4,500,000

The amount of fares paid by the population using the canal for passage in boats, and on the rail and other roads along its route, cannot be estimated at less than three dollars each per annum. The population using the canal route at the present time, may be estimated with sufficient accuracy by adding to the number in the canal counties, as above stated, viz: 710,000, for those from other counties, and parts of counties, who, through branch canals, and otherwise, now use the route of the Erie canal more or less, both for travel and transport, a number equal to about one half of the 606,470 assigned to the railroad within this State, making in round numbers, 1,000,000; which at three dollars each, amounts, per annum, to - - $3,000,000

Total, - - $9,000,000

which is equal to an average of nine dollars each, per annum, for travel and transport on that route, or about 12 per cent. of the value of the commodities transported.

In 1839, 1,435,713 tons were transported on the canals, valued at $73,399,764, on which the tolls received amounted to $1,616,382, of which $113,753 were collected on the Champlain canal.

The tolls actually collected on the canal, being the basis of this estimate, and the results, being, after large allowances, sufficient to justify the inferences to be made from them, it is immaterial whether the numbers stated as now using the canal, or the rates of fares paid, be exact or not. No reason is perceived why it may not be safely taken as a basis of calculation with reference to the railroad and the southern tier of counties. The inhabitants of these counties are not less industrious or less enterprising than those of the counties which border the canal. Their lands for all the purposes of agriculture, with exceptions in respect to wheat, are superior to those of the canal counties; their climate is more uniformly salubrious; and in their rivers, their forests, and their minerals, the difference is still more widely in their favor. If there be a reason, it is not apparent, why they should not have occasion to travel as much, and as far, as their northern neighbors, to procure for themselves a like quantity of supplies, and to pay for them by sending their products to market; or why they should not be able and willing to pay as much annually, for travel and transport, if favored with facilities adapted to all their objects, interests and wishes, and available from the Atlantic to the lake, in winter as well as summer. If the products of their agriculture are at present less, their lumber and their minerals are far more abundant. The railway will, to say the least, furnish them facilities of travel and transport as much more eligible and convenient than any others within their reach, as the canal and the road, along its route, do those using and supporting them. For through passengers passing west from the city of New York, and east from the lakes and western States, the prospects of the road cannot well be deemed inferior to those of the canal route, whether distance, time, expense, or comfort be most regarded.

There would seem then to be nothing very extravagant in anticipating for this road, which will be competent to as much business, and combines all the objects of the canal and the rail and other roads on its borders, an amount of income not vastly disproportioned to the amount paid for tolls, freight and travel on that route as above represented.

To those, however, who may think it most prudent to suppose the inhabitants of the southern counties to have fewer wants than their neighbors, less ability to supply them, and less occasion and leisure for travel, it may be more satisfactory to estimate their payments for the same objects at six, or at four and a half, instead of nine dollars each, per annum. At six dollars each for 800,000 the amount would be $4,800,000. At four dollars and fifty cents, it would be, $3,600,000.

Supposing then that a single track of the road finished in the best manner, with a heavy edge rail, and competently furnished with engines, cars, and all the requisite appurtenances should cost $9,000,000, the above estimate of six dollars for each inhabitant, deducting one-third, or $1,600,000 for expenses, which is deemed more than sufficient for such a road, would give an annual net income, on the cost, of thirty-five per cent. At four dollars and fifty cents each, the net income would be over twenty-six per cent. per annum. If only three dollars each be assumed, which would require the supposition that the travel and business of this population, would be but one-third as much as of that on the route of the canal, the net income, after deducting one-third for expenses, would amount to about eighteen per cent. per annum.

The result, in either of these cases, may appear preposterous to those who without informing themselves of the reasons why some roads and some canals pay dividends, and others do not, or why long ones may be productive, and short ones unproductive, reason and decide only from what they happen to know of some unfortunate work, constructed at an expense largely disproportioned to its object, located where, in the nature of things, it could command but a meagre amount of business, defective in its strength, or other qualities requisite to economy and success in using it, and subjected to the necessity of a sharp competition for whatever business it obtains. Such persons reason and decide like the emigrant, who having heard of feather beds as a substitute for straw, put their claims to the test by reclining on the floor with a single feather under him. The experiment satisfied him that if one feather afforded so little relief or so sensibly increased his fatigue, a bed full would be intolerable and fatal. Such logic is easily understood and is therefore current. It is put forth with the honest gravity of ignorance, or the solemn arrogance and impudence of hypocrisy, and whether designed to caution or betray, is surprisingly fruitful of mischief. If sleeping on one feather is tiresome and distressing, what prudent man, who desires repose, or values life, would venture on a bed containing thousands of them? If a short road does not pay, what can be plainer than that a longer one must be bad in proportion to its length.

The reasoning of this description and degree of merit, by which the original expenditures on the Erie canal were assailed and discredited, abounded in conversation and in print, especially among those who, of all the people in the State, were most interested in the construction and success of that work, and, therefore, most concerned to understand and to sustain its claims to confidence. It proceeded not from any knowledge on their part of any of the elements of calculation involved in the undertaking, but issued spontaneously from the state of their minds, and would doubtless be exhibited in like abundance now, had the project of that work been delayed, and were it but partially accomplished.

To judge of the claims of any such undertaking, and especially of railroads, because they offer the greatest facilities for travel, and likewise for transport, when properly constructed for that object, it is essential to inquire, first and chiefly, to what number of people will the work in question afford the most satisfactory means of travel and business? This may involve two subordinate inquiries; one, whether, and to what extent, the route is exposed to competition? the other, as to the tendency of the work to augment and multiply the employments and business of those who are relied on for its support, and to attract further accessions to the population. (See appendix, *Note D.*)

Where there are people enough for its support, a road adapted to their purposes, and so conditioned as to command their patronage, will of course be productive. The number of people to be served is, in connection with the length of the road, a far safer basis of calculation than any general or theoretical estimate of passengers and tonnage. There may be a great difference on different routes in the variety and extent of the employments and business of the people; and a more numerous population may be required on some routes than on others, to afford daily a sufficient number of passengers, in addition to their tonnage, to support a road. On a route through a salubrious and inviting country, occupied by a prosperous and increasing population, and affording scope and objects for ten times their numbers, a railway is a far safer investment than on a route which, though equally populous at the outset, presents no new objects of enterprize, or other inducements to immigration. On a road long enough to yield, on an average, $5 for each passenger, two hundred passengers a day, with their tonnage, would probably yield a better income on the same capital, than twenty-five hundred per day on a short road, yielding but fifty cents a passenger. A road requires a given number of passengers yearly, with their tonnage, to render it productive. If there are on its route people enough, their character, circumstances and employments being considered, to supply that number of passengers, and if growing numbers and patronage are in the given case to be relied on, in connection with the use and influence of such road, its success is certain.

Such a case is presented by this road. There is no mode of estimate or calculation on such a route, occupied by such a population, that will not justify all that need be claimed or presumed for this.

One consideration has, however, been omitted, which merits notice, and which, from its important bearing on the subject, did not escape the attention of the intelligent and practical men who have added most liberally to the subscriptions of the past year; namely, that on all that portion of the cost of the work which is discharged by capital borrowed, the annual dividend is limited by the rate of interest on the loan; consequently the dividends on the Company's stock will be larger in proportion as the earnings of the road exceed the rate of interest on the loan. Thus, if the income of the road is equal to 10 per cent. on its cost, it will pay 6 per cent. on two-thirds of the amount, and 18 per cent. on the balance.

Aware of the operation of this method, and of the security it gives at once to stockholders and to the lenders of capital, railway companies in England, in cases where the density of the population insures an abundant income, even on roads costing ten to twenty times as much per mile as this will cost, and where they find no difficulty in disposing of their stock to any required amount at a premium, limit the issue of shares to a portion of the expenditure, and supply the balance by loans. (See appendix, *Note E.*)

It may still be gratifying to some to have before them an estimate of the number of passengers required at a given charge for fare to support this road.

If then, there should be, including way and through passengers, a number equal to one hundred and five through each way per day, making for both ways sixty-six thousand a year, at $12 each for four hundred and fifty miles, or about two and a half cents per mile, the receipts would amount to - -	$792,000
And if the interest on $6,000,000, at 5½ per cent., be deducted, viz: - - - - - - - -	$330,000
the remainder, - - - - - - -	$462,000
will divide over 15 per cent. on $3,000,000 of stock.	
At $18 each, or four cents per mile, the balance will divide 28 per cent. on $3,000,000.	
If the number of passengers be equal to one hundred and fifty through each way per day, or one hundred thousand a year, the receipts at $12 each for fare, would amount to - - - - - - - -	$1,200,000
and interest be deducted as before, viz: - -	330,000
the remainder, - - - - - - - - -	$870,000
will divide 29 per cent. on $3,000,000 of stock.	
And at $18 each, the balance will divide 49 per cent. on the stock.	

Should the city of New York, the counties on the route, and the regions beyond, furnish passengers equivalent only to fifty through each way per day, or thirty-three thousand a year, the receipts at $18 each, or four cents per mile, the rate usual on other roads,

would amount to - - - - - - - -	$594,000
interest being deducted as above, - - - -	330,000
the balance, - - - - - - - - - -	264,000

will divide about 9 per cent. on $3,000,000.

As an illustration of the matters involved in these estimates, it may be observed that on the Utica and Schenectady railroad, seventy-eight miles in length,

the number of through passengers in 1839, was	95,776
and of way passengers, - - - - - - -	86,823
Total, - - - - - - - - -	182,599

equal to 125,102 through passengers; the fare through being $3, or a fraction short of four cents per mile. It is understood that the passengers transported on that road are estimated at not more than one-fourth of the whole number that pass between Utica and Schenectady, on the canal and otherwise, per annum.

The expenses of the year amounted to less than 30 per cent. of the receipts. The balance, after deducting all expenses, amounted to more than 15 per cent. on their capital. Had half of their capital been borrowed at 6 per cent., the earnings of the year, after paying the interest on the loan, would have divided 25 per cent. on the stock; or paid off the loan in four years of like receipts; or divided 10 per cent. per annum, and paid off the loan in six years.

The number of through passengers, as stated above, divided by the number of miles in the road, gives an average equal to 1604 passengers per mile yearly, 134 per mile per month, and 31 per mile per week.

100,000 through on this road would give 224 passengers per mile yearly, 19 per mile per month and 4½ per mile per week.

66,000 through would give 147 passengers per mile yearly, 12 per mile per month, and 3 per mile per week.

33,000 through would give 73 passengers per mile yearly, 6 per mile per month, and 1^{1} per mile per week.

On the Boston and Worcester road, 41 miles in length, the average in 1839 would be 2195 passengers per mile yearly, 183 per mile per month, and 42 per mile per week.

On the Boston and Lowell, 26½ miles in length, in 1838, 4905 passengers per mile yearly, 409 per mile per month, and 94 per mile per week.

On the Camden and Amboy, 61 miles in length, in 1839, 2984 passengers per mile yearly, 249 per mile per month, and 57 per mile per week.

Utica and Syracuse, 53 miles in length, in 1839, 2302 passengers per mile yearly, 192 per mile per month, and 44 per mile per week.

The number of way passengers on the Utica and Schenectady railroad amounted in 1839, to 86,823. The gross revenue derived from them, was $87,979,57, amounting to $1,01 for each individual; and as the charge for a through passage is $3, it is seen that the way passengers travelled on an average one-third the length of the road. It may be assumed as nearly self evident, that in a country occupied by a population distributed evenly over its surface, and having a uniformity of character and pursuits, the railroads which traverse it will receive numbers of way passengers proportional to their lengths; that is, a straight road two hundred miles long, will have twice as many way passengers as a road one hundred miles long. If we apply this principle to the case of the New York and Erie railroad, we may estimate the number of its way passengers from that on the Utica and Schenectady road, in the following manner, viz:

Miles. Miles.
78 : 446 : : 86,823 : 496,449=number of way passengers on the New York and Erie railroad. If we suppose the distance travelled by the above number of persons to be the same in proportion as on the Utica and Schenectady railroad, the average journey for each will be one hundred and forty-eight miles. At four cents per mile the sum paid would be $5,92, and the amount per annum received from all the way passengers would be $2,938,978,08.

To illustrate this view of the subject still further, we will make a similar estimate from data furnished by the Utica and Syracuse railroad. The length of this work is fifty-three miles; the number of way-passengers in 1839 was 55,802, who paid on an average seventy-three cents each, the price for a through passage being $2. By extending the calculations as above, we shall find that the number of way passengers on the New York and Erie railroad would, at the same rate, be 469,579, and the sum received from them, $3,056,959.

The amounts obtained in these calculations agree sufficiently to show that with regard to the railroads cited, the rule that the numbers of way passengers are as the lengths, holds good.

The mean of the two results is about $3,000,000, from which, if we were to deduct one-third for expenses, we should have a net receipt of $2,000,000 on way passengers alone; equal to 22 per cent. on the capital; or if two-thirds of the cost of the work were defrayed from loans, at 5½ per cent., the income on the remaining $3,000,000 of *stock* would be 55 per cent. per annum. In other words, if the New York and Erie railroad shall receive as many *way* passengers in proportion as the Utica and Schenectady, and Utica and Syracuse railroads, the net earnings might be more than sufficient to pay 5½ per cent. on $6,000,000 of loans, and 50 per cent. on $3,000,000 of stock, and this, without taking into account the profits on through passengers, on freight, or on the transportation of the mail.

Nothing can illustrate more forcibly than this the advantages which long roads possess over short ones. The results obtained may seem extravagant, and it is not intended to be asserted that they will from the first be realized; but when it is remembered that the Utica and Schenectady railroad has to the north of it a country which, as yet, yields very few passengers, and that on the south side it is in immediate contact with the Erie canal, which, during seven months of the active portion of the year divides with it the way business, and that the Utica and Syracuse railroad, having the same competition with the canal to sustain, has also the inconvenience of being constructed for nearly half its length across swamps, which are at present uninhabitable, whereas the New York and Erie railroad is every where free from these disadvantages, it cannot be deemed unreasonable that we should expect to profit to a very considerable extent from the principle above set forth.

The Boston and Lowell road is one of the best in the country, and is worked as cheap, or cheaper, than any other, in proportion to its length. But it is short, and notwithstanding its heavy business, both in passengers and tonnage, pays but about 9 per cent. per annum on its cost.

Of the railroad stocks in England, which are offered for sale, as quoted in the London Mining Journal, Railway and Commercial Gazette, of 26th December, 1840, all those which appertain to railways, of which the length is thirty miles or more, and which have been completed and in operation one year or more, are at a premium: viz.

Stockton and Darlington, 38 miles, including branches; opened, 1825; price, £275 per £100 paid up; premium, 175 per cent.

Liverpool and Manchester, 31 miles; opened, 1830, price, £185 per £100 paid up; premium, 85 per cent.

Grand Junction, 82½ miles; opened, 1837; price, £212 per £100 paid up; premium, 112 per cent.

London and Birmingham, 112 miles; opened, 1838; price, £169 per £90 paid up; premium, 87½ per cent.

London and Southwestern, 76¾ miles; opened, 1838 and 1840; price, £54 per £30 paid up; premium, 40½ per cent.

Great Western, 117½ miles, of which 63½ are finished; opened, 1838 and 1840; price, £89 per £65 paid up; premium, 37 per cent.

New Castle and Carlisle, 61 miles; opened, 1839; £105 per £100 paid up; premium, 5 per cent.

The stocks of a number of other roads which exceed thirty miles in length, up to one hundred and twenty-six miles, are quoted at various rates below par, but most of them are but partially constructed, and none of them had been completed and opened prior to 1840.

Of the numerous roads which are less than thirty miles in length, the stocks, without exception, are quoted below par.

Analogous to this, is the experience on this side of the Atlantic. Though the cost of roads here is comparatively small, and their character, as to routes, grades, curves, and superstructure, is quite various, it is believed that not more than two or three that are forty miles or more in length, and have been finished and in use twelve months, are unproductive, among which, the only one in New England or New York, is that from Stonington to Providence. Their earnings vary from 6 to 15 per cent. Some shorter roads are known to be productive, but it is deemed quite safe, and due to the subject, to state that of the roads which are completed and in use, those which are not productive are short ones. (See appendix, *Note F.*)

The report of the western railroad corporation of Massachusetts, dated March 1840, states that the net income of the railroads, finished in that Commonwealth, average over 8 per cent. per annum, on their cost.

In 1839, the net income of the Utica and Schenectady road was 15 per cent.; of the Utica and Syracuse, 14 per cent.; of the Camden and Amboy, 13¼ per cent

The foregoing estimates of passengers on this road, are made on the supposition that the freight both ways, would pay the repairs, and all other expenses, which may be taken at one-third of the receipts, or assuming the largest of these estimates, at $400,000 a year.

On the Erie canal, in 1839, about 160,000 tons of merchandise, products of animals, seeds, etc., were transported, of the value of $45,000,000, as stated in the report of the commissioners; and about 340,000 tons of manufactures, vegetable food, etc., exclusive of lumber, valued at $17,000,000, making 500,000 tons of the above mentioned articles, valued at $62,000,000.

The 160,000 tons of merchandize averaged in value, $280 per ton, and would, it may be reasonably presumed, be transported on a railway properly constructed for tonnage, in preference even to an adjacent canal, on account of its value, the difference of time occupied in its passage, certainty of calculation as to its arrival, less risk of damage, convenience in respect to the engagements and affairs of those owning ti, and other considerations of more or less force in different cases.

The 340,000 tons of manufactures, etc., averaged in value about $50 per ton, and would assuredly be transported on a railway on the shortest route to market were there no canal on such route.

Let it then be supposed, that of the above descriptions of articles, quantities should be transported on this road, equal only to 100,000 tons through per annum, and that the rate of profit on the transit of them should be one cent per ton per mile, the net receipts in such case, would be $450,000, or more than enough to defray the supposed amount of annual expenses.

Or if by being in operation 5 months of the year more than the canal, 50,000 tons of merchandize for the interior of this, and the western and southwestern States, should be tranported over the road at a profit of two cents per ton per mile, the like sum of $450,000 would be received.

It is therefore deemed as plain as success elsewhere or here can make it, that excluding all reliance on lumber, coal, and other minerals, there is room for the highest confidence of an abundant income. It is believed however, that when the road is in full operation, from 100,000 to 200,000 tons of coal, and a like quantity of lumber, will be transported on it, on an average, 150 miles; and that the number of passengers and the whole amount of tonnage will very far exceed the highest of the preceding estimates.

That the undertaking should nevertheless be decried, opposed and ridiculed, openly and secretly, elsewhere and here, is neither surprising nor discouraging; and the Directors accordingly have seen no occasion for noticing the calumnious accusations and assertions which have appeared from time to time in some of the papers of this city. They cheerfully submit their proceedings to the judgment of the Stockholders, and leave it to the citizens of New York to consider the bearing of this work on their landed property, their commercial affairs and prospects, their trade with the Western States, the winter supplies of their market, and on the resolved sagacious, and far reaching competition of Boston, sustained, as it is, and will be, by ample resources of capital, intelligence and untiring effort, which without such an avenue to the West, might prove more than equal to the natural advantages of the harbor of Sandy Hook.

By order of the Board of Directors.

ELEAZAR LORD, *President.*

(NOTE D.)

TOLLS ON COMMON ROADS INCREASED BY RAILROADS.

"The report of the minister of public works in Belgium, states a remarkable fact, and one at variance with the anticipations of most persons. It was supposed that this new mode of transport, introduced to the extent now practised in Belgium, would destroy the old, and that the use of horses and ordinary carriages would be superseded. Such is not the fact. On the contrary, while railroads have been, in succession, extending themselves over the whole of the soil of Belgium, the produce of the tolls on the ordinary roads, instead of diminishing, has progressively increased. In proof of this, the following statement of the produce of the tolls is given:—

1831, - - -	2,390,882*fr.*	1836, - - - -	2,447,985*fr.*
1832, - - -	2,195,343	1837, - - -	2,584,791
1833, - - -	2,360,464	1838, - - - -	2,759,543
1834, - - -	2,415,769	1839, 10 months,	2,749,301
1835, - - -	2,385,430		

Mr. Nothomb makes a comparison of the advantages to the public, in time and money, between the old mode of travelling by diligences, and the rate of travelling under the new tariff, which went into operation in 1839.

The average result is a saving of *half the time*, and of 33 per cent. in the price.

The saving in price is thus subdivided: in diligences 15 per cent.; chars-a-bancs 30 per cent.; wagons 60 per cent. It is the lower class who profit most by the establishment of railroads. They not only find the means of transport, which were almost denied them before, but they find the means of labor increased. It is officially stated in this report that the building of the railroads of Belgium has produced the result of increasing the produce of all the indirect taxes."

INCREASE OF PASSENGERS BY THE ESTABLISHMENT OF RAILWAYS.

"From Baron Charles Dupin's Report on the Paris and Orleans railway. Experience has proved both in France and abroad, that in a short space of time the facility, expedition, and economy afforded by railways more than doubles the number of passengers and the quantity of merchandize.

In order to support such statements, we will quote the followng facts relative to the railways of Belgium, England, and Scotland, in positions of extreme difference, and giving rise to a variation in the returns which far exceeded all anticipations."

" Comparison of the number of travellers conveyed daily throughout the whole, or a portion of the line :—

Railways.	*Before the establishment.*	*After the establishment.*
Manchester and Liverpool,	400	1,620
Stockton and Darlington,	130	630
Newcastle and Carlisle,	90	500
Arbroath and Forfar,	20	200
Brussels and Antwerp,	200	3,000

Increase of the number of passengers by the establishment of a Railway:

Liverpool and Manchester,	300 per cent.
Stockton and Darlington,	380 per cent.
Newcastle and Carlisle,	455 per cent.
Arbroath and Forfar,	900 per cent.
Brussels and Antwerp,	1,400 per cent.

Thus, even taking as a criterion the road on which the proportional increase is least of all, we still find that the number of passengers will increase not only 100 but 300 per cent. The transport of merchandise will experience a similarly rapid increase.

Progress in the conveyance of merchandize by Railway, compared to that of passengers :—

Year.	*Passengers.*	*Tons.*
1834,	924,063	22,909
136,	1,248,552	161,501
1838,	1,535,189	274,808

Thus while the number of passengers has increased 60 per cent. in four years, in the same time the quantity of goods increased 1,100 percent."

Extract from a late official report on English Railways, made to the French Government, by Edward Teisserence, its agent, charged with the special duty of making a study of these Railways :—

"The Darlington Railway has produced, by its low rate of passage an of freight, a complete revolution, in the region of country which it traverses. It has increased the value of land 100 or 200 per cent. By these low rates, the freight, estimated at 80,000 tons has been increased to 640,000 tons. The passengers estimated, at 4,000, have been increased to 200,000."

The following extract on the influence of Railways in developing the resources of a country, is taken from the second report of the Irish Railway Commissioners.

" On the Newcastle and Carlisle road, prior to the Railway, the whole number of persons the public coaches were licensed to carry in a week was 343, or both ways 686; now the average daily number of passengers by Railway for the whole length, viz: 61 8-10 miles, is 228, or 1,596 in the week.

The number of passengers on the Dundee and Newtyle line, exceeds at this time 50,000 annually; the estimated number of persons who performed the same journey previous to the opening of the Railway having been 4,000.

Previous to the opening of the Railway between Liverpool and Manchester, there were about 400 passengers per day, or 146,000 per year, travelling between those places by coaches; whereas the present number by Railway alone, exceeds 500,000.

In foreign countries the results arising from the same cause, are equally, if not more striking. The number of persons who usually passed by the road between Brussels and Antwerp, was 75,000 in the year; but since the Rail Road has been opened from the former place to Malines it has increased to 500,000; and since it was carried all through to Antwerp, the number has exceeded a million. The opening of a branch from Malines to Termonde, appears to have added 200,000 to the latter number; so that the passenger traffic of that Rail Road, superseding a road traffic of only 75,000 persons, now amounts to 1,200,000.

It is remarkable, that on this, as on most other Rail Roads, the greatest number of passengers are those who travel short distances, being as two to one compared with those who go the whole distance. This appears from a statement read by Mr. Loch, before the Statistical Society of Manchester, showing that between April 30th and August 15th, 1836, 122,417 persons travelled the whole distance, and 244,834 short distances; chiefly to and from Malines."

(NOTE E.)

The following is a statement of the whole cost, (including the amount raised by loans,) the lengths, the cost per mile, etc., of a few of the principal railways of Great Britain. In every instance, the cost which is given, includes the whole capital outlay, for roadway, buildings, cars, locomotives, etc. etc. The pound Sterling has been taken at $4,84.

LIVERPOOL AND MANCHESTER.

Cost up to the 30th June, 1840, $6,810,717, of which $3,726,195 is in stock, and the remainder has been raised by loans.

The length of the road is 30 66-100 miles.

The cost per mile has been $222,137.

The whole capital of the company, on the 30th June, 1840, including some items not properly chargeable to roadway and works, was $6,847,665. The earnings for the previous six months were at the rate of 8 4-10 per cent. on this capital, per annum. Whenever the dividends exceed 10 per cent. per annum, the tolls are by law to be reduced.

There are three tunnels at Liverpool, the aggregate length of which, amounts to 4506 yards, and which have cost more than $1,500,000.

STOCKTON AND DARLINGTON.

Cost $1,210,000: viz: Stock, $736,000, and loans, $484,000.

Length of the main line,	25.38	miles.
Four short branches,	12.75	"
Total,	38.13	"

The cost per mile, including the branches, has been $31,733. The dividends are £14 per each £100 share per annum, of which £10 per cent. is divided among the stockholders, and £4 per cent. is retained as a sinking fund. This road and its branches are used chiefly for the transportation of coal. Locomotive engines run on 24 miles; the remainder being worked by stationary engines and horse power.

GRAND JUNCTION.

The cost to the 30th of June, 1839, was $9,300,000.

Length (from Birmingham to Newton,) 82 63-100 miles.

Cost per mile, $112,550.

The whole amount of the company's stock at the present time, (all in shares or parts of shares,) including the cost of branches is 1$0,664,335.

The net profits, during the years 1838 and 1839. were 8 6-10 per cent. per annum.

LONDON AND BIRMINGHAM.

The cost to the 30th of June, 1840, was $27,580,135, viz: stock, $15,125,000, and loans, $12,455,135.

The length of the road is 112 1-4 miles.

The cost per mile has been, $245,702.

This road yields a profit of about 9 per cent. per annum, on the paid up capital. The gross income for the year ending 30th June, 1840, was $3,326,583, of which the receipts from passengers alone, were $2,446,518. The cost of land has been $30,000 per mile.

LONDON AND SOUTHWESTERN, (OR LONDON AND SOUTHAMPTON.)

Cost $9,943,228, viz: in shares, $6,776,000; in loans, $3,167,228.

Length, 76 7-10 miles.

Cost per mile, $129,639.

GREAT WESTERN.

This road is not yet completed. The amount expended up to the 30th June, 1840, was $21,819,494.

The whole length of the road will be 117 4-10 miles, of which 75 miles are now in use, viz: 63 miles at the London end and 12 miles at the Bristol end.

It is estimated that this road will cost upwards of £50,000 per mile, say upwards $242,000

The average number of passengers per day, on the London end of the line, for the last two and a half years, has been upwards of 1500. Up to the 30th June, 1840, the amount paid for lands and expenses relating thereto, was $3,475,449, being at the rate of more than $2,420 per acre, or $29,000 per mile.

NEWCASTLE AND CARLISLE.

Probable cost, $4,598,000, that being the amount authorized by parliament to be raised. Of this there is in stock, about $2,613,600, the remainder having been raised by loans.

The length of the road is 61 83-100 miles.

The cost per mile, has been $74,360.

New York, 3d February, 1841.

RAILWAY PROPERTY AS AN INVESTMENT.

"A correspondent calls our attention to the extraordinary increase in the value of railway property, which has taken place within the last six months. Comparing the quotations in our share list of the 14th December last, with those of the 13th inst., it will be seen that upon twenty lines this increase amounts to upwards of *eight millions Sterling!* Thus the Great Western shares in that period have risen *52l* per share, namely, from 10 discount to 42 premium, equal to 1,300,000*l.* upon the 25,000 original shares; the new shares have risen from 5 discount to twenty premium, equal to 625,000*l.*—making altogether 1,925,000*l.* upon the old and new shares. The London and Birmingham shares have in like manner risen from 50 premium to 99 premium, equal to 1,225,000*l.* upon the 25,000 original shares; the quarter shares have risen from 22 to 30 premium, equal to 200,000*l.*; and the new shares have risen 13*l.*, equal to 405,950*l.*; making altogether upon the shares a sum of 1,830,950*l.* The shares of the other lines in the following table, are computed in the same manner:

Great Western, ...	£1,925,000
London and Birmingham, ...	1,830,950
Grand Junction, ...	829,000
London and Southwestern, ...	612,000

Eastern Counties,	488,000
North Midland,	420,000
London and Brighton,	360,000
Manchester and Leeds,	312,000
Midland Counties,	240,000
Manchester and Birmingham,	180,000
London and Croydon,	165,000
Great North of England,	150,000
London and Blackwall,	120,000
York and North Midland,	120,000
Birmingham and Gloucester,	95,000
Chester and Crewe,	90,000
Bristol and Exeter,	90,000
Cheltenham and Great Western,	75,000
Birmingham and Derby,	63,000
London and Greenwich,	60,000
	£8,224,950

These results connot fail, as our correspondent remarks, to be most gratifying to Railway proprietors, as showing that public opinion has undergone a change; that railways are no longer viewed with suspicion as the mere speculations of a day, to be spoken of in the same breath with Spanish bonds, &c., but that they are regarded as real and valuable investments in the soil."—*Railway Times.*

DANGERS OF RAILROAD TRAVELLING.

"It is ascertained by experiment, that the danger of loss of life on on average Railroad trip is about 1 to 4,000,000. The following data on which this conclusion is founded, are copied from a late British publication:

Name of Railway.	*No. of Miles.*	*No of Pas.*	*No. of Accidents.*	
London and Birmingham,	19,119,465	541,360	3 cases of contusions, no deaths,	(1)
Grand Junction,	97½*	214,061	2 cases slight do,	(2)
Bolton and Leigh and Kenyon and Leigh,	3,923,012	508,763	2 deaths, 3 slight contusions	(3)
Newcastle and Carlisle,	61*	8,540,759	5 deaths four fractures.	(4)
Endinburgh and Dalkieth,	8*	1,557,642	one arm broken,	
Stockton and Darlington,	2,213,681	357,205	none,	
Great Western,	4,100,538	230,408	none,	
Liverpool and Manchester,	31*	3,521,820	8 deaths, no fractures,	(5)
Dublin and Kingston,	6*	26,410,152	5 deaths and contusions to pas'gers,	
London and Greenwich,	484,000	2,880,417	one passenger slightly bruised.	

* Length of road.

(1) None of these accidents occurred to actual passengers.

(2) None of these accidents occurred to actual passengers.

(3) None of the persons killed were passengers.

(4) One of the persons killed was a passenger.

(5) The whole of these were passengers; one of them a sergeant in charge of a deserter, who jumped off the carriage whilst in motion; the sergeant jumped after him to retake him, but was so much injured that he died; three others got out and walked on the road and were killed; the rest suffered by collisions of two trains, at different times. These include all the casualties from the very commencement of the working of the line."

(NOTE F.)

Statement of the cost, annual expenditures, receipts, etc., of several railways in the United States.

Name of Road.	Length in miles.	Total cost.	Expenses er annum.	Receipts per annum.	Profits per annum.	Per centage of profit	Number of through passengers.	Number of way passengers.	Total number of passengers.
Utica and Syracuse, July 1839 to July 1840.	53	941,475	65,648	197,923	132,275	14	74,034	5,802	129,836
Utica & Schenectady, 1839.	78	1,855,052	119,630	400,671	281,041	15	95,776	86,823	182,599
Boston and Lowel, 1839.	26½	1,608,476	92,151	241.219	149,068	9	130.000		
Boston & Providence, 1839	41	1,782,000	14 ,411	313.907	119,496	7	130.000		
Boston & Worcester, 1839.	44	1,848,085	126,384	231,807	105,423	6	90,000		
Camden and Amboy, 1839.	61	3,220,857	258,043	685,329	427,286	13¼			181,479
Philadelphia, Wilmington and Baltimore, 1839	97	4,379,225	169,130	490,635	321,505	7⅓			213,650

NOTE.—The whole number of passengers on the Boston and Lowell, Boston and Providence, and Boston and Worcester roads, are reduced to through passengers.

In the cost of the Camden and Amboy road, the cost of steamboats and some other matters are included, and the expenses and earnings of the boats at the ends of the road are also included in the statement.

From the Chevalier de Gerstner's statistics of the railroads in the United States.

"In order to give a more general summary view of *all* the railroads in the different States of the Union, the following statement contains a recapitulation of the number and length of railroads in operation and progress in each of the States, of the number of locomotives employed thereon, the capital expended and that required to complete the works in progress, the total cost of the railroads when completed, and the average cost per mile, to the end of 1839.

Name of State.	Number of railroads.	Number of miles in operation.	Total length of railroads.	Number of locomotives.	Amount of capital already expended.	Amount required for completion.	Total cost of railroads.	Average cost per mile.
Maine,	1	10	10	2	200,000		200,000	20,000
New Hampshire,	1	14½	29½	2	610,000	30 ,000	910,000	31,111
Massachusetts,	14	270½	365½	52	11,100,000	2,435,000	13,535 000	37,056
Rhode Island,	1	47½	47½	6	2,500,000		2,500,000	52,632
Connecticut,	3	94	152	7	1,905,000	1,000,000	2,905.000	19,079
New York,	28	453¾	1317¾	45	11,311,800	10,503,000	21,814,800	16,570
Pennsylvania,	38	576½	850½	114	18,070,000	5,042,000	23,112,000	27,183
New Jersey,	7	192	196	37	5,547,000	100,000	5,647,000	28,826
Delaware,	1	16	16	6	400 000		400,000	25,000
Maryland,	8	273½	749½	44	12,400,000	10,600,000	23,000.000	30.700
Virginia,	10	341	369	42	5,201,000	250,000	5,451,000	14,772
North Carolina,	3	247	247	11	3,163,000		3,163,000	12,806
South Carolina,	2	136	202	27	3,200,000	800,000	4,000,000	19,802
Georgia,	4	211½	640½	17	5,458,000	4 320.000	9,778,000	15.266
Florida,	4	58½	217	5	1,420,000	2,400,000	3,820,000	17,604
Alsbama,	7	51	432½	3	1,222,000	3,434,000	4,656,000	10,763
Louisiana,	10	62	248¾	20	2,862,000	1,834,000	4,696,000	18,880
Miasissippi,	5	60	210½	8	3,490.000	2,240.000	5,730,000	27,221
Tenneasee,	3	0	160½	—	1,100,000	855,000	1,955,000	12,180
Kentucky,	2	32.	96	2	947,000	1,250,000	2,197,000	22,885
Ohio,	6	39	416	1	420,140	2,859,000	3,279,000	7,883
Indiana,	2	20	246	2	1,375,000	3,425,000	4,800,000	19,512
Michigan,	10	114	738½	8	1,896,000	5,653,000	7,549,000	10,222
Illinois,	11	23	1421	2	1,832,500	15,177,500	17,010,000	11,970
Total,	181	3332½	9378½	463	97,630,440	74,477,500	172,107,940	18,351

It appears, from the above table, that at the end of 1839 *the number* of railroads completed and in progress in twenty-four States of the Union, in which this kind of improvement has already been introduced, amounted to 181, of which 3332 1-2 miles were opened and in use; 1707 1-2 miles besides were graded and ready for the superstructure, and the total length of all the lines undertaken was not less than 9378 1-2 miles.

The number of Locomotive Engines employed upon all the railroads in the United States, was at that time 463, (about one Locomotive for every seven miles of road.)"

READING, PA., Feb'y. 10, 1841.

Messrs. BALDWIN, VAIL & HUFTY,

Gentlemen:--I send you enclosed a statement of the performance of the "Hichens & Harrison" engine built by you for the Philadelphia and Reading Railroad, which will add to the already well deserved reputation of engines of your construction.

Very respectfully yours,

G. A. NICOLLS,

Supt. Transp'tn. P. & R. Railroad.

Statement of the performance of the Locomotive Engine "Hichens & Harrison," built by Messrs. Baldwin, Vail & Hufty, for the Philadelphia and Reading Railroad—

On February 9th, 1841, the above engine hauled over the Reading Railroad, 54½ miles in length, from Reading to its intersection with the Columbia Railroad, a train of *one hundred and five* loaded burden cars, loaded with 1318 barrels of flour, 870 kegs of nails and spikes, 635 bushels of grain, 63 tons of blooms and bar iron, 20 cords of wood, 8 casks of oil, and sundry other articles of freight, amounting in all to 308¼ tons of 2240 lbs.

Weight of the 105 cars, 173 tons, making a total gross weight of 481½ tons of 2240 lbs., equal to *one million seventy-eight thousand five hundred and sixty pounds* hauled by the engine, not including her own or her tender's weight. Cars all 4 wheeled; wheels 3 feet dia.; lard and tallow only used in boxes; whole length of train 1260 feet, or 60 less than one-fourth of a mile. Running time 4 hours 54 minutes, making an average speed of 11 1-10 miles per hour.

Total quantity of fuel consumed 2.51 cords of oak wood. Total quantity of water evaporated 1804 gallons. Oil used by engine and tender 7 quarts, oiling before starting. Longest continous level over which the above train was hauled, 9 1-10 miles. Her speed with the train on this level 10 9-10 miles per hour. Weight of engine, empty, 23,250 lbs.; with water and fuel, 26,710 lbs. Weight on driving wheels, with water, fuel and two men, 14,120 lbs. Cylinder 12½ in. dia., 16 in. stroke. Driving wheels 4 ft. diameter. The above road has no *ascending* grade from Reading *towards* Phiadelphia, with the exception of a half a mile at its lower terminus or intersection with the Columbia Railroad, graded at 26½ feet per mile, on which grade the train was stopped.

The profile of the road from Reading to this point is divided into levels, varying from 1600 feet to 9 1-10 miles in length, and *descending* grades of from 1½ to 19 feet per mile, the latter being the heaviest grade on the road.

Total length of level line between the above points 27 8-10 miles. Total fall, from where the train was started to where it was stopped, 214 feet, Shortest radius of curvature on the road 819 feet; 1840 of curve struck with this radius.

The engine started the above train on a level without any assistance, and gradually increased her speed to the average rate above mentiondd.

She worked with great ease to herself during the whole trip, and hauled the train for the last 14 miles, 10 of which were level, over rails in very bad order, owing to a light snow storm which moistened without wetting their surface, the effect of which in diminishing the adhesion and power of the engine practical engineers can well understand and appreciate.

The above performance is believed to be unsurpassed, and the train to be the longest and heaviest ever hauled by *one* engine on any railroad in Great Britain or America.

Reading, Pa., Feb. 10th, 1841.

Great and Judicious Reduction of Railroad Fare.—We announce with pleasure the following good news, for travellers, farmers and invalids. The directors of the South-Carolina Canal and Railroad Company, after much deliberation on the policy and expedieney of the measure, have determined to remodel and reduced the rate of passage money and freight, on the road to Hamburgh, in compliance with the recommendation of a committee charged with the subject. The following is the scale of reduction—Fare through, from and to Charleston and Hamburgh, $8 instead of $10—shorter distance, and from one intermediate station to another, on the line, 6 cents per mile instead of 7½ cents. Carriages. having two horses, conveyed through, for $20 instead of $40, with the privilege of a servant to each pair of horses, carriages, gigs and sulkeys, &c., for a less distance than through the whole line, to be charged from 25 to 40 per cent below the present rates, according to distance, number, &c. Servants and children, under 12 years of age, half price.

It is also comtemplated to appropriate a car (as soon as practicable) expressly for the accommodation of those, whose means, inclinations, or infirmities, may lead them to prefer it, at two-thirds or one half the full prices. It has moreover been determined to provide cars, for the speedy transportation to the city of the marketable products of the country, such as fruit, poultry,eggs, butter, &c., and to return as promtly with a supply of sea-board luxuries, such as fish, oysters, West India fuit, ice, &c., to regale the palates of our country friends. Lastly, in order to encourage excursions for pleasure or health, a ticket, purchased for any distance on the road, is to entitle the party to return, the same day, free of charge; a privilege which will doubtless be highly valued by the party of pleasure, for a day at Woodstock, or other seat of rual attraction, the man of business, and especially the sportsman and the invalid. Those regulations are to be carried into effect, say from the 5th to the 8th inst.

We have also been informed that the Company have at last effected an arrangment with the authorities in Augusta, by means of which they are to enjoy, in petuity, the right of passing the Savannah River, and estabishing a *depot* in that city.

OCMULGEE AND FLINT RIVER RAILROAD.

It will probably be a matter of *news* to most of our readers to learn the name and location of the project of such a work; and, also, that it is in a fair way to be caried into actual being and existence. There has been granted, a charter for a Railroad from Albany, Baker County, on the Flint River, to the Ocmulgee, in Irwin County. We can inform those ignorant on this subject, that the Company has been formed—all the stock taken—and the Road surveyed and located, and the work ready to be Commenced. The route, as might be anticipated, is very favorable. The work to terminate on the Ocmulgee, at Mobley's Bluff, a short distance above Jacksonville. The length of the Road will be seventy-six miles. It is proposed, to complete it for present use with wood rails, and for horse power only.—This can be done at a very moderate expense: and as business may increase, locomotive power may be introduced. The region of country it will connect with our cities on the Atlantic coast, is fertile and productive of our great staple; and it will tend to a great extent, to concentrate trade and provide a market for our produce, within our own borders, which heretofore has found one in another State,—Macon Messenger, 21st inst.

NATURAL STEEL ORE.

In the town of Duane Franklin Co, State of New York, a mine of Natural steel ore has been opened, and worked, from which, without any additional substance the Messrs Duane who occupy a large blast furnace in, that, town have, the present season, *cast* a variety of *edge tools*, such as axes, hatchets, adzes, plane irons, knives, chisels, tailors and tinman's shears &c, &c, which all prove to be first rate tools, having a fine edge, and when well polished, showing a lustre equal to the best cast steel. The ore was smelted in the blast furnace and run into pigs, from which the tools were cast. The oftener the metal is re-melted the better the steel becomes, as fire does not injure its qualities as it does in manufactured steel. When first cast, the metal is remarkably soft, yielding readily to the file or turning chisel, and is capable of being tempered to any required degree of hardness—so as to resist even the file. It has all the properties of the best cast steel, nor can these properties be injured by fire as in other steel; but if the temper is missed you may repeat the operation as often as necessary without injuring the steel qualities.

Messrs, Livingston & Lyman, 32 Commerce street, have some of these tools, were they may be seen and tried.

The Liverpool correspondent of the N. York, Times thus describes a work by which a railroad is carried *over* a town:

Last week was completed the greatest work of its kind, ever executed in this country. This is the Stockport Viaduct. The contractors being Liverpool men (John Tompkinson and Samuel and James Holme, builders,) hundreds of people from this place went on December 21st to veiw its completion.

The Manchester and Birmingham direct line of railway now runs *over*, not *through*, the town of Stockport. The arches literally stride over that large town. Standing in a valley, in Chesire, the town of Stockport is too low for the level of the railroad. Mr. Buck, the engineer, had the first stone laid on the 10th of March, 1839, and the last, or capstone, on the 21st of December, 1840. Thus, in 21 months was completed a viaduct, based on the solid rock, of 30 arches—26 of 63 feet span and 4 of 29 feet span: The length is 1786 feet. It stands 111 feet above the Mersey which flows beneath; and is thus 6 feet higher than the Menai bridge. The foundation, in the sandstone, is six feet deep, and 9 feet of stone work above ground. From thence to the springing of the arches the peirs are of brickwork, and the huge bends of the same material. Brick was used, as less likely, when well made, to chip, splinter, or decay. The quantity of bricks used amounted to 11,000,000, there were also used 400,000 cubic feet of stone, and the whole cost 70,000.*l* The utmost *settling* in the whole work, after taking the wooden supporters from the arches, is half an inch.

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 6, Vol. VI. New Series. | MARCH 15, 1841. | Whole No. 378. Vol. XII.

Owing to a multiplicity of causes, our Journal has not reached subscribers at the proper time. Among them, we may mention changes in our printing office, which have contributed to the present delay, but will enable us to afford still greater facilities for the future.

A large number of communications are on hand, and will appear as rapidly as possible.

Communications have been received from Messrs. Rockbury, Latrobe, Earle, Olmstead, Smith and Cushman, also, from Smeaton. We are much indebted for several very excellent articles, and have to apologise for the delay in presenting them to our readers.

We are also under obligations to Messrs. Fessenden and Schlatter, for valuable documents which have been kindly forwarded with great promptness.

We take great pleasure in presenting the following paper of Mr. *Roebling*, on the subject of Suspension Bridges. The labors of Mr. *Ellet*, have contributed to bring this matter into general notice, aup we are glad to find that other Engineers are turning their attention in that direction. No time can be more suitable for the discussion of Suspension Bridges, and we hope soon to see this class of structure coming into general favor.

For the American Railroad Journal and Mechanics' Magazine.

SOME REMARKS ON SUSPENSION BRIDGES, AND ON THE COMPARATIVE MERITS OF CABLE AND CHAIN BRIDGES.—*By J. A. Roebling, Civil Engineer. No.* 1.

The subject of suspension bridges is beginning to engage the attention of the profession. To cause public opinion to incline in favor of this species of structure, can only be accomplished by the successful erection of some good specimens. The ocular demonstration they will offer, will advance this cause more than all treatises. Among the profession, however, this matter cannot be too much discussed, provided the discussion is carried on by men who are familiar with the features of the system.

The writer takes this occasion to remark that he has, ever since the introduction of suspension bridges upon the continent, made himself intimate with the system, that he had some excellent opportunities of becoming practically acquainted with the details of construction, and that he has, with devoted interest, taken notice of all the improvements which have gradually been introduced.

Chain bridges originated in their improved form in England, and were, in the course of a few years, introduced into France and Germany. The material of which the chains in most of these bridges are manufactured, is common iron. The bars, composing the links, are generally about 15 feet long, 4 inches deep, and three-fourths of an inch thick, therefore presenting a sectional area of 3 square inches.

The difficulty of insuring the iron in such dimensions of an uniform and even quality and strength throughout, is obvious, and hence the large quantity of iron expended in chains to insure strength and safety. The general practice has been to allow from 16 to 20,000 lbs. per square inch, as the maximum strain to which chains should be subjected in the most trying case. This is rather less than one-third of the actual strength of iron bars. A far greater allowance of strength is made for the suspension rods, which are more liable to be seriously affected than the chains. Experience and fatal accidents which have occurred to some carefully planned and executed suspension bridges have proved that the usual allowance of strength for the chains and rods is not by any means too ample. With the exception of some accidents which were the results of defects in the bars, and which only prove that the latter had not been sufficiently examined and tested, it can be shown that the most serious injuries to which suspension bridges may be subjected, can be guarded against more successfully by some alterations in the system, and by resorting to some simple expedients, than by a mere increase of strength in the chains.

On the occasion of the erection of several suspension bridges over the arms of the Danube, in the city of Vienna, a body of scientific Engineers undertook a series of experiments on the strength of different sorts of iron, steel and wire. The actual capacity of iron to sustain a powerful strain uninjured, does not so much consist in its ultimate tenacity as in its elasticity. A bar of good iron may sustain a strain which approaches the limits of its strength without breaking, but a succession of such trials, which are beyond its elastic capacity, will gradually stretch it permanently, and cause at last a rupture.

Any strain upon a bar of iron, no matter how trifling, will produce an actual elongation of its fibres. Owing to the elastic quality of iron, the fibres will contract again as soon as the cause of the strain is removed. But this will only take place to a certain extent. The extent of the elongation to which the fibres may be subjected without having their power of contracting at all impaired, is the limit of elasticity on which we can safely rely. Therefore, iron should never be strained beyond this limit. This rate of elasticity in common bar iron amounts to about one third of its ultimate strength. If, therefore, thirty tons are required to break a bar of iron of one square inch, the strain it can support without injury, will amount to ten tons. If this strain is frequently repeated, and applied for a considerable length of time, it should be reduced to eight tons or even less.

The result of the experiments at Vienna was, that the Engineers decided in favor of steel as the material to be used for the chains; the elastic power of this metal, and the greater uniformity of its grain, being so much superior to that of iron, that greater strength and safety could be obtained for less expense by using it instead of iron. It is proper to remark here that the steel used in these bridges was manufactured of natural steel ore, and cost but little more than iron.

Note.—Natural steel ore is found in abundance in Austria, and in the famous mining districts of Seigerland, in Prussia. A few remarks on the Muessener mountain in the latter district may not be uninteresting to those who intend to visit the continent and the river Rhine, from whence they can easily reach the celebrated steel mine at Muessen. The steel ore has no resemblance to common iron ore, and looks more like crystalize feldspar than any thing else. The mine at Muessen where this ore is found in its greatest purity, has been worked since time immemorial, and it is computed, that when the ore is exhausted, the mere pillars, which are now left to support the roofs, will furnish a supply for many centuries more.

This mine is not worked in the common way, and has a remarkable appearance. The visiter descends a broad flight of steps, arched over at a convenient height to walk upright. Arrived at the floor of the gallery, he finds himself at the entrance of a mag-

Since these steel suspension bridges were constructed, wire cables in place of chains were more generally introduced by the French Engineers, and gradually prevailed over the whole continent.

The superiority of wire cables over chains cannot be contested for one moment, why the English Engineers still cling to the old system, after they have seen the principle of wire cables successfully tested, and particularly after they have witnessed the success of the Friburg bridge, which exceeds the Vienna bridge in boldness. Why, after so much experience, they do not abandon the use of chains, is to me truly a matter of astonishment.

The ultimate strength of wire as used in cable bridges, is two-thirds greater than that of iron bars as used for chains. The proportion of elasticity to the ultimate strength is greater in wire than in iron. 52,000 lbs. may be relied on with safety, as the extent of the elasticity of wire per square inch.

On the other hand, iron is much cheaper in the form of bars of several square inches section, than in the form of wires of $\frac{1}{8}$ inch thick. But the manufacture of wire cables is a great deal simpler and cheaper than the manufacture of chains. The cost of a wire cable bridge will generally be found less than of a chain bridge of the same strength. But there are some peculiar features belonging to the cable system which should decide in its favor even at an advance of cost.

The process of wire drawing, imparts to the iron a great uniformity of grain. If a strand is made of good iron, and sound at its ends, it is generally good throughout. Unsound places are mostly visible on the surface. The toughness of wire strands is easily examined by testing the two ends. The actual test of all the strands throughout can likewise easily be effected.

A cable is constituted of a great number of wires. Admitting now that a few unsound strands, in spite of all care and vigilance,

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nificient hall and succession of halls, with dome shaped ceilings supported by pillars. These excavations have been made in the solid ore, and the effect of the reflection of the light, when properly illvminated, from the millions of crystals of ore composing the walls, all around, is very beautiful and fairy-like. This sight is worth a trip of 100 miles to enjoy.

The South American market, and part of the West India market is largely supplied with all sorts of implements and cutlery, made of this natural steel ore.

[It may be well to remark that a similar ore is not uncommon in the United States. [Ed. R. R. J.]

should find their way into a cable, their number would be too small to affect the strength of the whole materially. All the single wires are coated with a durable varnish, and the finished cable is coated again, and may be effectually protected against the influences of the weather by a tight wrapping throughout. The wrapping has also the advantage of preventing the unequal expansion and contraction of the inner and outer wires, when exposed to the rays of the sun, and sudden changes of temperature. Cables can in this manner be more effectually protected against oxidation, than chains of bar iron. The beauty of a well manufactured cable is, that all the component parts are uniformly placed and equally strong throughout. Each single strand bears exactly its portion, and thus the greatest strength is effected by the least amount of material.

The floor of a chain bridge is suspended by vertical iron bars, in cable bridges these suspenders are formed by small wire cables, which should always have an inclined position. Even where a chain bridge should be found preferable to a cable bridge, the suspenders should be invariably made of wire. Wire suspenders are pliable, and will easily move with the floor, when set in motion by the wind. The fastenings of the suspenders at the two ends cannot give away; but it has frequently occurred on chain bridges, that the heads of the suspension rods have been snapped off in consequence of the wresting and twisting.

I will notice here the remarks of Colonel Pasley upon the effect of storms, communicated in the Transactions of the Institute of Civil Engineers:—

"By the hurricane of October 11, 1835, one-third part of the road-way of the Suspension Bridge at Montrose (410 feet span,) with a very small exception, was carried away. The suspension rods on the west side were either broken or very much bent, but the chains, 4 in number, and extending in two parallel lines, of two tiers each, appeared perfect. It is our opinion, based on observations, that the motions which a bridge experiences, are not *lateral*, but *longitudinal*. The Hammersmith suspension bridge does not appear to be subject to these longitudinal motions, even in a most violent gale, and this is amply accounted for by the longitudinal trussing which is there adopted. The idea, that these longitudinal motions, and the injuries to the road-ways of suspension bridges, are owing to the violent action of the wind from below, is confirmed by what Colonel Pasley witnessed in Nov. 1836, at the Chatham Dock Yard. One side of the roof of a shed for ship building, was raised up and down repeatedly, until at last, a large portion of it, about 40 to 50 feet, was floated up like a sheet of paper, and carried to a distance of 50 yards. Such being the violence of the wind, we may readily conceive that the continual extension and compression to which the suspension rods must be subject, by the rise and fall of the road-way, is prevented in the Hammersmith bridge, by four lines of strong trussing along the whole length of the road-way, firmly connected to the bearers below. No similar trussing exists in the Menai, the Montrose, or any other suspension bridges which Colonel Pasley has seen. The rise and fall of the platform of the Menai bridge is confidently stated to be three feet in ordinary gales, so that unless some similar trussing be employed, it may reasonably be expected that this bridge will be seriously injured in some future hurricane. The peculiar construction of the suspenders in several pieces, with joints, is a source of security to this bridge which the others do not possess. The author believes that no suspension bridge of 400 feet betwixt the piers can be considered secure without two inflexible lines of longitudinal trussings from pier to pier."

For the American Railroad Journal and Mechanics' Magazine.

PRESERVATION OF TIMBER.

The following is copied from an *informal* report made by Mr. R. M. Bouton, the intelligent director of the "process" for the U. S. ordinance department, at the Watervliet arsenal, N. Y.; where, during the last summer and autumn, he has been employed in preparing a large quantity of timber for the public service. The *official* report, intended to be made, being delayed by the unfinished state of some experiments thought necessary to its completion; these facts and inferences are given in anticipation, by Mr. Bouton, with full assurance of their general correctness.

1. That the cost of the process, embracing the mineral salts, labor, and fuel employed, need not exceed a half to two and a-half cents per cubic foot of timber; varying with circumstances which need not be here particularized.

2. That different kinds of timber receive the benefits of the process in different degrees of facility and time; the latter extendtending from 24 or 48 hours to 3 or 4 days, or more.

Chestnut, hemlock, black walnut, ash, elm, oak, birch, hickory, maple, white wood and pine, are affected by it with variations of time and facility pretty much in the order in which they stand.

3. That the *density* of the wood is evidently increased; yet that it works well, and without injury to tools.

4. That *toughness* is also decidedly increased in ash, elm and hickory, (as actual employment of these woods at the arsenal has

already proved) ; and, by inference, that other kinds of lumber will be similarly affected.

5. That the *strength* also of the three kinds, just specified, is certainly increased ; affording a legitimate conclusion in favor of others.

6. That the effects produced on green and seasoned timber are not ascertained to be importantly different.

7. That, in short, *all* the sensible manifestations of timber, thus treated, indicate very important improvement ; which is confirmed by the use of several, as already stated ; while no evidence whatever is afforded of deterioration, or of diminution of any valuable property."

To these specifications, Mr. Bouton adds his unreserved opinion that "this process will be proved, by experience, fully equal to the purposes intended."

It is gratifying to be able to add to other evidences, long before the public, in favor of this process, the testimony of this gentleman so well known for his intelligence, and cautious and correct observation. And, as connected with the above, I would refer for other strong testimony on the subject, to the No. of this Journal for January 15th, p. 53.

EDWARD EARLE,
Phila. Feb. 27, 1841.

☞ The improved apparatus, which I have lately adopted for the process, may be constructed to suit any purpose, and of various costs—from $75 to $250 ; the last of which is equal, with suitable tanks, to the preparation of 2000 to 3000 cubic feet, at an operation.

For the American Railroad Journal and Mechanics' Magazine.

February, 1841.

In a late number of the Journal, I observe an attempt by "Fulton," to reduce to something like a uniform plan, the future prosecution of improvements within the State. Whether that he proposes be the very best that might be propounded or not, I think it must be admitted to be, in itself a laudable effort to do what is very much needed ; and that, at lest, most of his suggestions and provisions are judiciously conceived.

It is very evident that Fulton's bias is strongly in favor of railroads in preference to canals,—a subject of which, in the phrase of good Sir Roger, "much might be said on both sides ;" and then, probably, it would be agreed, by compromise, that neither the one nor the other but that both are best. So I think. But however this may be—many canals are already constructed, especially in our own State, and are very efficiently doing their duty. They therefore must be maintained; but if experience has taught that railroads are, on the whole, to be preferred, we shall not be wise in neglecting its lesson in our future undertakings. That the State should be a stockholder in every railroad, and should exercise, in many respects, a chief agency and controling influence, is a prominent position of F. and is urged with force. Much expansion might be given to the few strong reasons to which he has confined himself; and his doctrine is, in the main, so sound that I would hold to it under State-exigences much more considerable than those which exist. In the view, indeed, we are permitted to take of our financial condition—especially, if we make that view prospective—there can be no hesitation in admitting both the policy and prudence of the State's extending liberal aid to every such undertaking that promises a fair result. These modes of intercommunication between distant points of the State, and of intercourse and connection with other States, are fraught with advantages of which experience, hitherto, has given us but a glimpse;—of which it is hardly possible, indeed, to form a sober-seeming estimate. In my own anticipations of their importance and productiveness I might suspect myself of overstepping good discretion, were I not sustained—it might be more proper to say prompted—by the example of Governor Seward in his late message to the Senate and House of Representatives. In that able and Statesmanlike paper, of which it is difficult to determine whether intelligence or benevolence,—the soundness of his head or the goodness of his heart—is the prominent feature—his excellency has traced a view of our future prosperity, and internal commerce as unlimited almost as the west itself—whither he directs it.

If the revival, he seems to think at hand, should come indeed, and bring with it a "distribution of surplus revenue" from the sales of our national territory,—what advantages and blessings may we not expect from the judicious appropriation of them to such objects as he has recommended!—of these, internal improvement is a principle one; which already is becoming paramount to most others. The present and succeeding years are likely to be busy in such work; for the spirit of improvement has gone forth with an impetus not likely to be arrested, and will receive fresh vigor from the constant succession of its own accomplishments; for our country, extensive in territory and rich in various wealth, presents so broad a surface and so many excitements to the industry and enterprise of its possessors, that it were a sort of "sullenness against nature" not to avail ourselves of her overtures;—and such is not our character. It is a fact however, which ought not to be passed without remark, that our public works have been executed with less regard to permanence than there is reason to believe they might and, if might, they certainly ought to be.

Already pretty largely a contributor, and likely to be more so,—to those improvements, and prompted by more than selfish feelings to desire their progress and success,—I will here suggest, as supplementary to "Fulton," what ought to be, if practicable, a part of every such undertaking in order to secure to them a continuance of public favor.

Next, in importance, to the construction of a canal or railroad at all, should be the care to secure its duration;—that it be so done and with such materials, that the outlay be not lost in early failure from delapidation or decay. For it is a maxim worthy of general acceptation, that what is worth being done is worthy of being well-done. To this purpose, therefore, whether the work be a canal or railroad—the timber to be used in the construction should be selected with judgment; and this should be one of the earliest provisions of the company, that it may be as thoroughly seasoned as possible before it is subjected to the destructive alternations of the weather in its destined positioni and become, as it generally does, the most active consumer of those profits which, otherwise, might constitute a most satisfactory dividend to the stockholders. Nor, if there be any scientific mode of treating it to insure its duration, that can be relied on, ought it to be neglected, unless, indeed, the cost of such treatment be more than commensurate with its advantages. Other occupations have compelled inattention to this matter; but I collect from occasional notice of them in the Gazettes, as well as from the "Railroad Journal," that there are several well-accredited methods of accomplishing this very desirable purpose, and that one of them is being extensively employed by the war department at the Watervliet Arsenal in this State. This would imply a preference of it by that department—whether for efficiency or economy or both might be easily ascertained, and deserves inquiry by those whose appropriate duty it may be. Effect and ecomomy being the motive of preference, I would propose that the State (supposed to be already a Stockholder according to the suggestion of "Fulton,") authorize an inquiry into it by a competent person, and also bear such share of the expense of employing it as shall be equal to its interest as a stockholder, viz., if one-third, then one-third, etc., and to insure to the timber the full benefit of a proper application of it, that the same competent person be appointed by the State to direct and superintend it. This would relieve the individual stockholders of much of the expense, while, to the State, it would be annihilated by being only an extension of the right it may be supposed to have acquired for the use of the process on works wholly and exclusively of the State. If timber may, by such means, be made to endure two, three, or perhaps four times as long as otherwise it would, and at an expense of one-sixth or one-eighth of its first cost, as is represented—would the State, as a stockholder, consent to forego so great advantage, or an individual decline his proportion of a charge to be returned to him in, often, multiplied amount?

This is altogether deserving early attention, that the advantages of such a method, if it be ascertained to exist, may not be lost to those works which are now in progress and about to be. Nor can I conceive a more judicious appropriation that the State could make than of such a sum as may be supposed necessary to secure the right to use it as here suggested. One other particular I will advert to as I have not seen it recommended before, which, also, ought to be subject to the control of the State; and that, of all railroads henceforth to be constructed, the tracks should be of a uniform width. The conveniences resulting from such agreement are too obvious and multiform to require enumeration. But this suggestion is offered on the presumption that the State becomes, as it is greatly to be hoped she will, a party to all future constructions of this kind.

PHILO FULTON.

CHATHAM CENTRE, *Columbia county, N. Y.*
January 26, 1841.

To the Editors of the American Railroad Journal, and Mechanics' Magazine.

GENTLEMEN:—I would say a word about a communication that appeared in your Journal of the 1st October, signed by J. E. B., relative to the cost of depots and grounds for railways.

Your correspondent, J. E. B., either misunderstands the reports of the engineers of the (Mass.) Western R. R. or he has not paid enough attention to it. He says, "The Western R. R. Co. of Mass., over the mountains and rocks of Berkshire, have paid at the average rate of $1700 per mile, or about $200 per acre," and adds that the general width of railroads is 4 rods or about 8 acres to the mile.

The laws of Mass. alow R. R. companies to take 5 rods and they always do take 5 rods, even when the grade of the railroad runs along on the surface of the ground—thus making about 10 acres to the mile. Again, the Western R. R. is nearly as often *fifteen rods* wide as 5 rods, in Berkshire county—varying from 10 acres to the mile to 30 acres.

You see that I am reducing Mr. J. E. B's $200 per acre, pretty fast; but I have not done yet—to proceed—

The report of the engineers does not separate Berkshire county from the rest of the line west of Springfield in the average cost per mile of the land—consequently it is hardly fair to take the average cost per mile of their whole western part of the line, which is very much raised by going through many valuable farms nearer to Springfield, and apply it to the "mountains and rocks of Berkshire," besides, when a railroad passes through such a large and thriving town as Pittsfield, the average rate is raised considerably, and a railroad in Mass., goes through a more thickly settled country, land more valuable for building lots, manufacturing and other purposes than the wide spread territory of New York. Again—the $1700 per mile includes the cost of *land*, the *building and keeping in repair fences, moving buildings* and a few other items. About $600 per mile should be allowed for fencing and keeping it in repair—from 90 cts. to $1 per rod. Between Springfield and Chester, a distance of 30 miles, no less than *twenty-eight* buildings were moved—other instances might be given where buildings were moved at a great expense.

I think, Messrs. Editors, that the actual cost of the land—(land only)—may be set down a considerably nearer $2 per acre than $200—two than two hundred.

For the American Railroad Journal, and Mechanics' Magazine.

A BRIDGE AT THE FALLS OF NIAGARA.

Messrs. Editors:—On visiting the Falls of Niagara, much as the mind of man is struck with astonishment and awe at the vastness and sublimity of the scenery, at, and in the vicinity of the "thunder water," the magnificent and indescribable work of nature: he feels not a little surprise and admiration in viewing the power which his own species has displayed in constructing a safe and permanent bridge over a very considerable and rapid portion of the cataract from the American shore to Goat Island.

A person who has never been engaged in such constructions, marvels much at the success of that undertaking, and leaves the scene, under the impression that the work must be the *ne plus ultra* of bridge making, and retires, satisfied that he has seen and passed over, probably, the most extraordinary viaduct in the world. The ambitious engineer, or bridge architect, however, investigating the plan, which was put into successful operation at that point, examines other places in the vicinity, to find whether he could not construct a rival work, the very existence of which would carry his name down to the most remote posterity. Forgetting the romance of the mighty cataract, he contemplates the hydrostatic power which it presents. He sets imaginary water wheels in motion, five hundred feet in circumference, and in his mind creates a poetical saw mill with power sufficient to cut the British possessions into small scantlings. He looks forward to the time when manufacturers will erect machinery sufficient to employ every drop of the waterfall, (as they have already almost done at Rochester) and two populous cities spring up on the opposing shores, rivaling each other in metropolitan magnificence. He is now employed by air-created, town council's as engineer of the cities, and required to build a bridge across the Niagara river above the awful abyss! But how in the name of wonder can this be done?

Indulging in this species of castle, (or rather) *bridge* building, on a recent visit to the Falls, a plan occurred to me, Messrs. Editor, which carried out, I am very certain, would accomplish this apparently monstrous undertaking, and piers of a bridge could actually be erected on the very brink of the horse shoe precipice.

To effect the object, I should proceed as follows:—

On the smooth water, as short a distance above the rapids as possible, I would endeavor to find a point where both shores are precipitous—and at this place I should build a sort of wharf-like abutment of timber and earth on both sides of the river, and opposite each other. I should then construct a number of *caissons* on the shore, in such form as that they might be joined together in regular concatenation, and fit each other at the joints so as to be water tight. The lower part of the chain of *caissons* should be formed so as to fit as nearly as practicable the bottom of the river on a line between the two abutments above mentioned. I should now launch these structures into the stream, and floating them to their destined position, sink them for the purpose of forming a temporary dam across it.

Previous to the above operation, I shall have procured and prepared materials sufficient to raise the piers of my bridge above the reach of the water of Niagara, and also to erect centering for the arches of such a character as would not be interfered with on the current. These preparations having been made, the shortest time in which the piers and centering could be erected by a force applied to it. Night and day should be calculated, and then the Niagara river should be gauged with the utmost accuracy.

I should now ascertain, the superficial area of lake Erie, and also the areas of planes parallel to it, bounded by the shores, but 1, 2, 3, &c., to 6 feet higher than its present surface; and taking the quantity of water which falls at the great Niagara leap; discover by calculation, the height which that quantity, falling into the lake would raise it above its present level, during the time which would be required in the erection of the piers and centering. To this height, I should raise the temporary dam, and then proceed with masonry at the Falls.

Supposing the dam to be constructed, and made nearly water tight, the water below it would very soon disappear over the precipice and leave the bottom of the stream comparatively bare, at least sufficiently so not to interfere with the operations. Against this plan there might be an objection urged, that raising the lake would very materially damage buildings, storehouses, wharves, etc. at other cities erected close to the waters edge, and possibly the Erie canal below Buffalo might be interfered with. But it appears to me, without, however, having made any calculation that it would require at least four weeks for the natural supplies of Lake Erie to raise it four feet, (a period amply sufficient, with skilful engineers and mechanics to complete the operation required) and there is scarcely any part of the shore of Lake Erie which I have seen, where so small a rise upon previous notice having been given, that it would take place, could be productive of serious consequences.

The whole project, you will perceive, Mr. Editor, is given vaguely and with no particular data whereon to base minute calculations. The principles on which it could be carried into effect, are all that is necessary to set forth at present, in order to convey an idea of its practicabilities.

Very extensive and minute surveys of the lake shore, should, of course be made, and, also, calculations of probable damages and other estimate of the cost should be gone into. I merely submit the project to your readers as a matter of amusement, for the time at which such a work would be needed is too far distant to require us to consider the subject with any other motive.

At a half-hazard guess I should estimate the cost of a permanent shore bridge, *erected on a line tangent to the horse shoe Fall of Niagara,* from the British shore to Goat Island—including surveys and all other contingencies—at one million, five hundred thousand dollars.

SMEATON.

West Greenville, Pa. Jan. 1841.

Description of a new form of edge rail, to be called the Z rail, with its supports, fastenings, etc.—*Making with it a part of a railway track of a new construction*—*With estimates of the strength and stiffness of the rail, etc.—and of the cost of the track—and a comparison of it in these particulars, with other forms of railway.*

The undersigned solicits the attention of his professional brethren, and of others interested in the improvement of the railway, to what he presents under the above head. Although great progress has been made in the advance of this important structure towards perfection, under the impulse which it has received from the united talents and industry of the body of Engineers and Mechanics, who have been for the last ten years emulating each other in its improvement, still, it must be confessed, that perfection has not yet been reached. Daily experience upon the best railways of Europe and America, exhibits defects for which remedies are sought in each successive new work that is constructed. In laboring, along with the rest of his profession, to detect and remove these imperfections, the undersigned, in the range of thought which these efforts involved, has had presented to his mind the novel idea which he now offers, and which appears to him to be entitled to be regarded as at least a further step in the course, if not an arrival at, the goal. He is aware that the railway, like every other machine, having a single object in view, is yet capable of assuming a variety of forms, all of which may in a measure, produce the desired result. It is, however, no less true, that among these forms, one must be better than all the rest, and to it its competitors must ultimately give away. Among the T, the H, and the inverted ∩ or Bridge rails, one wonld at last supersede its fellows; and the course of things is already tending fast to a selection and preference of one of the three. The question being, upon which does the choice promise to light, the undersigned would venture the opinion, that it will fall on the last of the three;—not because it is theoretically the best form of section, but because it will wear the best in its practical use—on account of its better supported top, and the greater spread of its base, and the greater facility it affords for making the joinings good. But supposing the question of the best form of iron rail settled, as between the three sections just mentioned, in favor of the Bridge rail, the best manner of *supporting* it comes up still for decision; and herein the opinions of Engineers will find room for many differences. Some will advocate the entire rejection of timber, and others its very free employment, in the substrurture of the track. In the first of these extremes, the English Engineers were, until recently, to be found; but they are now becoming aware of the great value of wood as a component part of the railway structure both for the means it affords of making it a connected piece of *framing*, and for the relief from concussion and jar, which its elasticity yields to the machinery and to itself. These excellent properties are beginning to be jusly esteemed as more than a full compensation for the perishabiility of timber; and since the profession in Great Britain, where durability in all public works is so highly prized, and aimed at in total disregard of first cost, is showing this disposition to patronize this perishable material, from a conviction of its superior advantages in other respects, it may be, it is thought, fairly inferred from present appearances, that the *wood* and iron] will supersede the *stone* and iron railway. Looking, then at America, a glance at the railways of *New* England, where expense of construction has been, as in *Old* England, but lightly regarded in comparison with economy of *repairs*, confirms the inference just drawn; for upon but one of the railways of the Eastern States are stone supports employed, and that one of the earliest opened in that section of the Union.

This general conclusion in favor of timber being admitted, there are still important questions open respecting the details, and the first of them is, whether the wood should be so disposed as to give the rail a *continuous bearing* or not. And it is apprehended that this point will not remain long in dispute, and will be decided in the affirmative; for it can be shown that the continuous bearing does not necessarily involve the use of more timber, (in obtaining equal strength of structure,) while it gives great additional support to the rail against all the strains to which it can be subjected. Starting, then, from this last point, even if it be a little in advance of *unanimous* professional opinion at this moment, the undersigned offers his new form of rail, to which the continuous bearing is *necessary,* without much fear that it will *on that account,* be condemned in its comparison with sections of rail to which such a support is not absolutely essential.

Description, etc.—The accompanying drawing exhibits the plan in its details, allowance being made for the following modifications, which have recommended themselves for adoption since the drawing was printed, viz:—The rail, string piece and undersil are made 21 instead of 18 feet long—the string piece is sunk 1 inch instead of $\frac{5}{8}$ into the cross-tie, and the foot of the rail descends $\frac{3}{8}$ of an inch into the tie, instead of resting on its upper surface.

The Track now described, will consist of the longitudinal under-sills, (a, a) 3×10 inches in the section, with cross-ties (b, b) $3\frac{1}{2}\times6$ and 7 feet long, placed upon them at intervals of 3 feet from centre to centre, and upon the cross-ties notched 1 inch deep to receive them, will rest the string pieces (c, c) (of the trapezoidal section shown) 3 inches wide at top, $5\frac{3}{8}$ at bottom, and 5 inches deep. A treenail $1\frac{1}{4}$ inches diamater, is driven vertically through the 3 timbers at each cross-tie, excepting the ties on which the string pieces join, where there are two treenails of 1 inch diameter. Both under-sill and string piece are 21 feet long, and break joints with the rail, (also 21 feet long) and with each other. The section of the rail (d, d) resembles the letter Z, the head or upper table being turned to the one side of the stem, and the foot or lower table to the opposite side. The rail is placed against the inner side of the string piece, with the upper table lapping over the upper and inner edge of the string piece, and thus bearing on the *top* of the latter; and the lower table resting upon the cross ties notched down $\frac{3}{8}$ of an inch to receive it. A continuous top bearing on the string piece, and detached bottom bearings on the cross-ties, are thus obtained. The rail is held against the upright inner side of the string piece by horizontal screw bolts (e, e) every 3 feet, which pass through the stem of the rail about midway between its top and bottom, and through the string piece; the head of the bolt bearing against the rail, and the nut, with a thin washer, against an open morticed seat in the outer slope of the string piece. These bolts (being 9 to each bar of 21 feet) are placed at points midway between the cross-ties, excepting the two in each bar at its end, which come over the cross-ties on which the joints of the rail occur. The rail is further confined laterally at its foot, by the shoulder of the notch into which it descends, and also held down by a hook headed spike (f, f) driven vertically into each cross-tie. At each joining of the rails, a cast iron joint plate (g, g) is let into the cross-tie, to increase the bearing of the rails at these weaker points; this plate having on the outside a ledge to confine the feet of the rails, and two holes in it to permit the spikes lapping over them, to be driven downwards into the tie. The track thus constructed, will rest on a bed of broken stone, sand or gravel ballasting, 10 feet wide at bottom, 8 feet at top, and 12 inches deep, which will be filled up to the top of the cross-tie, and 1 inch above the bottom of the string piece, and leave a depth of $5\frac{1}{2}$ inches below the under sill for drainage, etc.

The rail is intended to weigh 45 lbs. per yard—its whole depth is 5 inches, thickness of stem $\frac{9}{16}$ of and inch—top bearing for the tread of the wheel $1\frac{1}{2}$ inches, total breadth of upper table $2\frac{1}{8}$ inches—breadth of bearing of upper table on the string piece $1\frac{1}{4}$ inches—breadth of foot inclusive of stem $1\frac{9}{16}$ inches—the whole breadth of the upper and lower bearing surfaces $3\frac{1}{16}$ inches—bolt hole in the stem $\frac{5}{8}$ of an inch diameter.

The proposed rail, and the structure of which it is a part, will admit, of course, of a variety of proportions. The forms and sizes of the several parts shown in the preceding description and annexed drawing, are considered suitable and sufficient for a track intended for the heaviest tonnage and highest speeds. It is hardly necessary to say, that the rail and its fastenings, in combination with the string piece and cross-tie, form the only subjects of claim to invention; as the under sill, ballasting, attachment by treenails, and even the trapezoidal form of the string piece (for economy of timber) are none of them new elements of the railway structure.*

Estimated strength and stiffness of the rail and cost of the track.—In calculating the load and deflection of the rail and string piece, the well known, formulæ of Professor Barlow, contained in his excellent work on the strength of materials, published in 1839, have been employed; and as they are based upon correct principles of mathematical analysis, skilfully applied to carefully conducted experiments, they are entitled to the confidence of the profession.

The strength of the rail, for a bearing of 30 inches (taken at the *clear* distance between the cross-ties, which are supposed to be 3 feet from centre to centre) is ascertained by the rules just mentioned to be $8\frac{3}{16}$ tons; or in other words, this is the load which the rail will sustain at the middle of the bearing without impairing the elasticity of the iron. From this, however, will be deducted the fraction of $\frac{3}{16}$ of a ton, to compensate for the effect of the bolt hole in the bar (an ample deduction) and the strength will remain equal to 8 tons. This last is about 15 per cent. (considered, and correctly, by Barlow, to be sufficient) beyond the *double* of the mean strain which the bar will be subjected to, assuming that strain to be $3\frac{1}{2}$ tons pressing through a single wheel. The strength of the string piece, regarded as a rectangular beam of 5 inches deep and 4 inches wide, is found from the formuæ of the same writer, to be $2\frac{41}{100}$ tons, which acting with that of the rail, makes a conjoint strength of $10\frac{41}{100}$ tons. This quantity of $2\frac{41}{100}$ tons, does not indeed represent the full strength of the string piece (or what it would bear within the limits of its elasticity) but merely the additional weight applied to the middle of the rail (and through it uniformly, or nearly so, diffused over the string piece) which would be necessary to bend the string piece under the rail, as much as the rail itself will bend under the

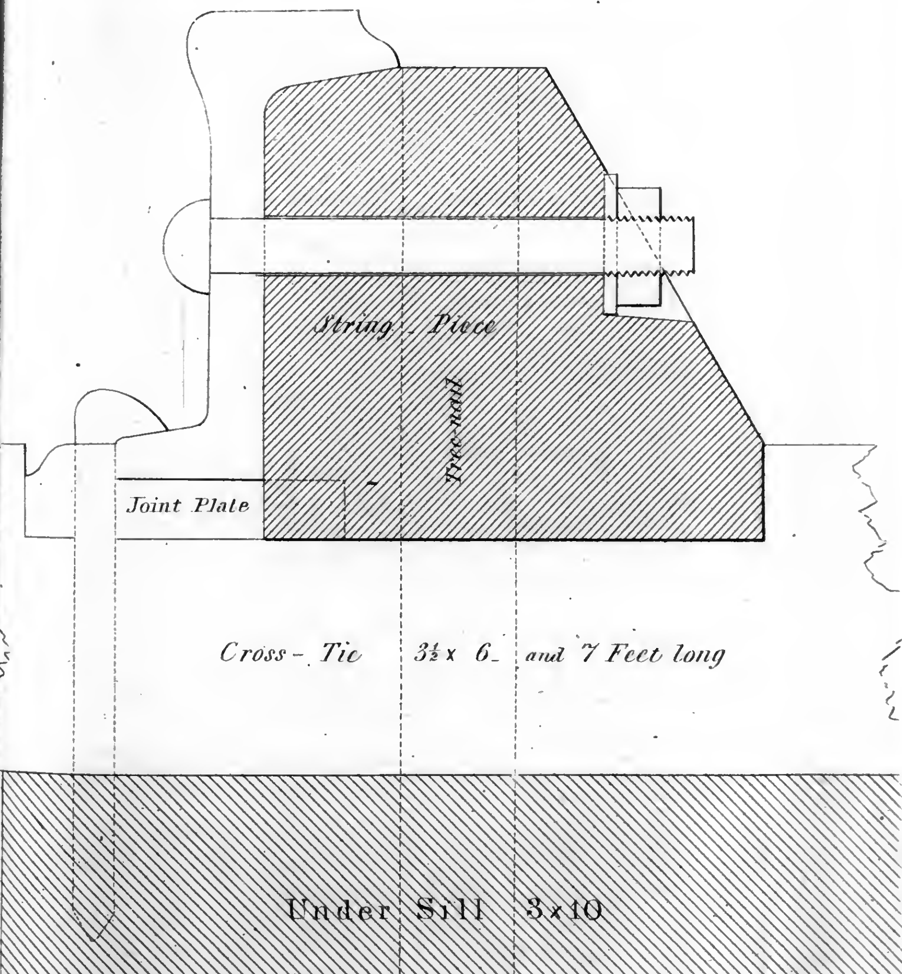
* The rail as shown in the drawing, has a slope given to the under side of the upper table, in order to make it a little stronger in its connection with the stem. This makes a corresponding slope in the part of the top of the string piece, forming the seat of the rail. The inclination (though not at all essential to the plan,) is not enough to do any *harm*; as the *friction* of the wood and iron would suffice of itself to prevent *sliding*. The sloping seat of the rail may be easily and quickly prepared, and the corner of the string piece rounded, by a planing tool with a properly shaped cutter. It is well known to be necessary to dress (generally with an adze) the top of the string piece for the common plate rail, to amend imperfect sawing. The string piece of the Z rail will be readily sawed into its trapezoidal form at the mill. The open mortice forming the shoulder of the nut of the screw bolt, will be cut so as to *drain itself* of water falling into it. The trenail head may be caulked and pitched, to keep the water out, or driven obliquely so as to put its upper end under the top of the rail. In other details of construction, improvements may perhaps be made upon the plan now presented, retaining its general features.

Z. RAIL

HALF SIZE DRAWING

of the Cross Section of

Rail, String-Piece, Cross Tie, Under-Sill &c.



Lith by E. Weber & Co. Baltimore

above weight of 8 tons. The rail and string piece, therefore, together form a beam capable of supporting nearly $10\frac{1}{2}$ tons for an indefinite time —a degree of strength much more than sufficient for every possible exigency.

The deflection of the rail alone, under the above load of 8 tons, will be .035 or $\frac{1}{29}$ part of an inch, but combined with the string piece it will be but .027 or $\frac{1}{37}$ of an inch; for as a load of $10\frac{41}{100}$ tons is necessary, as just stated, to produce the former deflection in the rail and string piece acting together, so a load of 8 tons (the assumed maximum) will produce in them only the latter deflection. These results exhibit a very stiff, as well as strong rail, and in the comparisons to be presently made between the Z rail and other rails, it will be seen how considerable an advantage the former possesses in regard to combined strength and stiffness over rails of similar weight with itself. Stiffness is a very important property in a rail, more so, indeed, than *ultimate strength,* which is seldom or never called into action, as the rigidity of the bar diminishes the deflections between the supports, which subtract from the efficiency of the moving power, and give more vertical motion to the machinery. A rail supported on wood, let it be as stiff as it may, will have a sufficient relief from concussion in the compressibility of the timber.

The *estimated cost* per mile of single track of the proposed railway, is as follows: the scale of prices contained in the subjoined note being applied to the several items of material and workmanship.*

Ballasting, 1,725 perches of 25 cubic feet, at $87\frac{1}{2}$ cents,	$1,509 37
Under sills, in 21 feet lengths, 26,400 feet board measure.	
String pieces, do. 19,800 do.	
46,200 do. at $25 per M.	1,155 00
Cross-ties, 1,760, at 20 cents each, - - - - - -	352 00
Tree nails, 4,024, 1 do. - - - - - - -	40 24
Screw bolts, nuts and washers, 4,527, weighing $\frac{3}{4}$ lb each = 3,335 lbs. at 12 cents, - - - - - - - - -	407 40
Hook headed spikes, 4,024, wg. $\frac{1}{3}$ lb. each = 1,341 lbs. at 9 cts.,	120 69
Joint plates, 503, wg. 3 lbs. each = 1,509 lbs. at $4\frac{1}{2}$ cts., -	67 90
Rails, $70\frac{71}{100}$ tons, at $70 per ton, - - - - - -	4,949 70
Workmanship of laying track, at $2,75 per rod, - - -	880 00
Total per mile, - - - - - - - - - -	$9,482 30

No allowance is added for turn-outs, sidings and road crossings, such as would be proper in an estimate for actual construction, as the extent and

* The following prices are assumed as a fair and full average for the whole United States, at the present time. In many parts of the country all the materials specified can be procured at cheaper rates; but on the other hand, there are many districts in the interior where they will cost more, on account of the expense of transportation, want of saw mills to cut the timber and other causes of enhancement of price. At all events, the operation of the present scale of prices will be impartial in the comparisons of cost contained in the tabular view of the several railway structures exhibited further on—

Sawed timber, $25 per M. feet, board measure.
Cross-ties, from 20 to 45 cents a piece, according to the size.
Tree nails, 1 cent a piece.
Ballasting, $87\frac{1}{2}$ cents per perch of 25 cubic feet.
Screw bolts, from 12 to 16 cents per lb., according to the size.
Spikes, 9 cents per lb.
Castings, $4\frac{1}{2}$ cents per lb.
Rails, $70 per ton.
Workmanship, from $2 $62\frac{1}{2}$ to $3 per rod, according to plan of track.
These prices including delivery and distribution of materials along the line of road, ready for use.

cost of these accessories must depend upon the special circumstances of each case.

The statements exhibiting above the strength and stiffness of the rail and string piece, and the view of the general stability of the track afforded by a scrutiny of the plan as shown in the preceding descriptive drawing and estimates, and in the subsequent comparative table, will, it is believed, satisfy others, as they have the undersigned, that no line of railway, however great its business, will be likely to require a structure of *greater* strength than the one here presented. There may, however, be lines of lighter business, for which a lighter construction would answer; and in reference to such, the undersigned would express a belief, that a rail of the form he proposes, and weighing not more than 35 lbs. per yard, would form, in combination with the timbers of the present plan, a track of abundant strength.* Such a reduction in the weight of the rail, and an appropriate corresponding diminution in that of the fastenings, and a small one in the cost of workmanship, would (all other things remaining as above) leave the cost of the track $8,176 per mile. If, in addition, however, to these curtailments of quantity in the materials just specified, we reduce, as we may for many localities, (especially in the sandy districts of the seaboard) the cost of ballasting to 37½ cents per perch, and that of lumber to $18 per 1000, cross-ties to 17 cents, and workmanship to $2,50 per rod—the cost of the modified plan per mile, would be but $6,897.

The plan and probable cost of the proposed new track having now been fully exhibited, the undersigned proceeds to speak of the advantages which he believes it offers, and by which he hopes it will recommend itself to the favor of those whom he addresses. And in respect to the comparisons with other plans which follow, he begs permission to assure the eminent engineers who originated them, that he means not to detract, in the smallest degree, from the merit which belongs to their design and execution; but on the other hand, fully acknowledges his own obligations to them for the services which they have severally afforded him in maturing his own invention. Indeed, the new idea which he now presents to the profession, is but the offspring of his studious consideration, and comparison with each other, of all the forms of railway structure known to him; and it will be seen that he, (without intending to apply to himself, the language above addressed to his professional brethren,) includes the work which he himself projected and constructed (the Baltimore and Port Deposit railroad) among those in which there exists room for improvement. And in making this general acknowledgment, he is happy to offer a more particular one of indebtedness to his friend, John Edgar Thompson, Esqr'., chief engineer of

* The rail thus reduced in weight, would have a head and foot nearly as heavy as the 45 lb. bar, but its stem would be reduced to ½ inch in thickness, and to 4 inches in total depth. The strength of the rail alone would be then, for a 30 inch bearing, 5.72 tons, with a deflection of .060—and the united strength of rail and string piece with that deflection, would be 9 85-100 tons, which, indeed, falls but little short of the similar result, with the 45 lb. rail. The reason of this is, that the greater deflection of the 35 lb. rail permits the timber to be strained to the full limit of its strength—which the stiffer 45 lb. bar would not allow. The advantage then, of the heavier rail is, that of the total strength of rail and string piece, the rail constitutes 76 per cent. while the lighter rail contributes but 58 per cent. to the aggregate strength of itself and the string piece. It is obviously desirable, that the least perishable material (viz. the iron bar) should possess the larger share of the united strength. Heavy timbers will give great strength with short bearings, and this is the kind of strength which the plate rail track may possess, but it will not compensate for the want of stability and stiffness in the iron bar; and the best proportion between the wood and iron of a track is, that in which the wood has just bulk and weight enough to give sufficient bearing surfaces to the *rail and its fastenings*, to prevent the crippling of itself under the strains to which it submits. In the Washington Branch, and Baltimore and Port Deposite Roads, there is more timber than is necessary, (see the tabular comparison below) and hence the excess of strength in the rail and spring piece, shown in the ninth column of that table.

the Georgia railroad, from whose ingenious suggestion of a T rail, with its stem confined between two string pieces bolted horizontally together, he first derived the idea of the Z rail and its accompanying support of timber.

The following is a brief enumeration of the particulars in which the undersigned considers his new rail an improvement upon the previous forms of the edge rail :—

1st. The lateral support given by the string piece to the rail, aided by the lateral strength given to the stem of the latter by the foot or lower web, permits the bar to be made thin and deep without the danger to which the stem of the T rail is subject, of buckling, or bending sidewise, under vertical pressure. Greater strength and stiffness is thus attained in the Z rail, with a given weight of metal, than in the plain T rail—and also than in the H rail, or Bridge rail; for in both of the latter sections, the width necessarily given to the base, for stability of position on its support, prevents the extension of the depth of the bar, sufficiently for the attainment of the strongest and stiffest form.

2d. The mode of connection between the Z rail and its string piece, makes the latter supply the place of the heavy and expensive chair demanded by the T rail, while the Z rail still enjoys (and in a still greater degree than the T rail) the superior strength and stiffness due to the *depth* of its section.

3d. The same mode of connection gives a continuous support to the upper table, which is not had by any other form of section. And this support not only extends the bearing surface on the wood, but immediately upholds, by an elastic cushion, that part of the head which, in the T and H rails, is so subject to crush, split off and wear away under the wheels; a defect of these sections which will, it is believed, occasion ultimately their entire disuse.

4th. The position of the rail on the *inside* of the string piece, makes the resistance of the rail to the outward lateral thrust of the flanges, as great as that of the string piece itself, a result which cannot be obtained so simply, effectually and economically, by any of the modes of fastening the rail on the *top* of the string piece, which must be employed with the H, or Bridge sections. The push of the flange against the rail, it is well known, is *the* force to be provided against, and this provision is made in the Z rail by the mere effect of its peculiar form; while other rails must be kept laterally in place by auxiliary attachments of iron, the bearing surfaces of which being individually small, must be multiplied expensively and injuriously to the wood, by wounding it at their points of insertion. The fastenings which attach the Z rail to the string piece, are subjected to little or no strain by the side action of the wheels, and are therefore left to the sole duty of maintaining the contact of the bar with its supporting beam, for the preservation of the joint action of the two in resistance to vertical pressure, and securing the correct *line* of the road.

5th. The attachments of the rail to the string piece by a number of bolts passing through both, efficiently resists the tendency to endwise movement in the rail, the prevention of which has heretofore been so imperfectly guarded against. The contraction and expansion of the bar will be provided for, by the elastic yield of the wood at the bolt holes.

6th. The *lining* of the inner edges of the rails at the joints, and the springing of the bars to, and their maintenance in, the curve of the road, will be effectually secured by the horizontal attachments of the rail and string piece. The importance and the difficulty of these adjustments must be acknowledged. The difficulty of making the tops of the bars fall in the same horizontal place, is occasioned by the unavoidable differences in their *heights.* The simplest and best way of compensating these discrepancies is, probably, to raise by a detached elevation, the part of the cast chair or joint plate on which each of the uniting rails is to rest, and then the highest of the two bars can, by a proper tool, have its seat reduced by the amount of the excess in its height. This compensation will be required for the Z rail as for all edge rails. But the lateral adjustment of the rails to a line at the joints will, in the Z rail, be effected simply by the screwing of the stem against the string piece; for after this is done the break, if any, which may show itself in the line of the inner edges, must be produced by a difference in the thicknesses of the slender stems of the two contiguous rails, which, (unlike the variation in their heights) must be inappreciably small. In the broad base of the H rail as much room exists for discrepancies in the width as in the height of the bar, and where the lateral alignment of the rails is effected through the lower web, it is very liable to imperfection. The T rail is less subject to this difficulty than the H rail, and the Bridge rail (in consequence of the facility afforded by the hollow in its base, and into which the chair may be made to go up) still less than either; but the Z rail (it is considered) is the least liable to it of all. And in regard to the bending the bars to, and retaining them in, the line of curvature, the advantage of the Z rail over the H, and the Bridge rail, is obvious; both from the more moderate lateral stiffness of the Z rail, and the more direct action and extended resisting surface and adjustibility of its fastenings. The wide bases of the H and ∩ rails on which their strength and stability mainly depend, render them, it is well known, very difficult to deflect in curves, and next to impossible to prevent them from returning to the condition of *chords* from that of arcs, into which they had been temporarily forced in the construction of the track. The great increase of resistance and concussion in the passage of trains through curves stiuated in this way, need not be demonstrated.

7th. The Z form of the section is the best adapted to bear the action of the wheels, the *coned* part of which, nearest the flange, imparting the most intense pressure, is received immediately by the *stem* of the rail, in which resides the main strength of every rail bar. In the T and H rails the stem is chiefly acted on through the inner ledge of the upper table, with a twisting action, unfavorable to the resistance of the bar; this part of the head suffering also much more severely from the wheel than the outer ledge. In the bridge rail, the inner leg or half of the stem receives the principal action; the outer one being strained to a less extent—an inequality injurious to the strength and wear of the rail.

8th. The simplicity of form of the Z rail section must make the rolling of it easier and cheaper than that of any other edge rail; while the disposition of the fibres and laminæ of the bar is as favorable as possible to strength and the endurance of wear.*

9th. In efficiency, accessibility and capability of adjustment, the fastenings of the Z rail track possess, it is thought, strong points of superiority. The heavy strains and shocks to which railways are subject, and the consequent disposition of the numerous parts composing their structure, to give way and *work*, one with another, renders it very important that the attachments of those parts should be constantly open to inspection and very accessible. Fastening capable of being readily tightened after working loose, such as keys or screw bolts, are preferable therefore to spikes, or simple screws without nuts. But screw bolts used to fasten rails on the *top* of a

* This opinion has been confirmed by that of a professional gentleman of great practical experience, in the manufacture of railway bars.

timber support, must have either head or nut *under* the timber and buried in the ballasting, or filling of the track. In either case the bolt is much more difficult of inspection and adjustment, or removal, than the horizontal bolt of the Z rail.

10th. The new proposed track is finally recommended by economy in the first cost and subsequent repairs, when contrasted with any known form of track of *equal strength of construction.*

In the "comparative table" below, there are three tracks, viz: the Philadelphia and Reading, the Washington branch, and the Balimore and Port Deposit, which are nearly identical with the Z rail track of 45 lbs. per yard, in estimated cost—while three others, viz: the Camden and Amboy, the Newcastle and Frenchtown, and the Wilmington and Susquehanna, fall short of it by from $350 to $750 per mile. The comparison of strength, stiffness and general stability between these tracks and the Z rail track (45 lbs. per yard) which is contained in the columns of that table, from the 8th to the 16th inclusive, will however, justify the claim of greater economy of construction and repairs in behalf of the latter. And if we go to the Z rail track of 35 lbs. per yard, we see an actual saving of $567 per mile in first cost, over the cheapest of the others, and with, *all things considered*, a stronger structure; for the strength of the *track*, as a combination of parts, does not depend solely on the strength of the rail, but largely on the stability of the *connections* of all the parts, in which particulars (as shown in the 14th and 15th columns) the lighter Z rail is seen to be much better provided than the tracks with which it is here compared.

To facilitate the formation of correct opinions in regard to the propriety of the preceding claims to improvement upon existing forms of track, the undersigned has prepared the following tabular view of the principle details of proportion and construction, in a number of the best built railways of the United States. The report jointly made in January, 1838, by J. Knight, Esq. and himself has furnished most of the information here made use of. The strength and stiffness of the several railway bars have been calculated by Barlows's formulæ. The amounts of timber in each track and of iron fastenings, have in some cases been but approximately estimated, but with not much error, it is believed, in any case. The resistances to vertical, lateral and longitudinal movement, are also estimated for each plan with (it is thought) but little variation from those actually obtaining in fact, and in every instance, with the most favorable suppositions, for the several tracks, that their form of construction seemed to justify. In the column of *estimated cost*, is contained an estimate of the expense of constructing each description of track, under the same circumstances and by the same scale of prices (the one contained in the note to page 177;) as if a railroad company, being about to adopt a plan of track, were to exercise its choice among all those here presented, and compare their several costs by the same set of measures of value. But it must be noted, that in order to a fairer comparison than could have been made upon these plans, precisely as they were, in fact, constructed upon the several works to which they belong, there has been added an undersill 3 × 10 inches, to those which are, in fact, without this support for their cross ties; and a bed of ballasting 8 feet wide at top and 10 feet at bottom, and one foot thick, has been included as a part of the cost of each. With these exceptions, each plan is estimated just it was in reality laid down, (with due allowances for possible imperfections in the information of the undersigned.) The tracks brought into the comparison are those only in which the supports of the rail are of timber, and several important railways more recently laid than those of the table, such as the western and eastern railways of Massachu-

TABLE, exhibiting the comparative weights, strength, stiffness, bearing surfaces, etc., of the edge rails used upon some of the principal railways of the United States, with the relative quantities of timber, etc., employed in the superstructures connected with the several rails, and the estimated cost of tracks per mile.

NAME OF RAILROAD ON WHICH RAIL IS LAID.	Weight of rail pr. yard linear.	Number of tons of rails per mile, per track.	Number of lbs. cast iron fastenings per mile.	Number of lbs. of wrought iron fastenings per mile.	Number of feet of timber, b'd measure, pr. mile in the track as constructed.	Number of feet b'd measure pr. mile, with undersill 3x10 added to the tracks without one	Strength of the rail in tons for a clear bearing of 30 in.	Strength of the rail and string piece combined, for same bearing.	Deflection of rail under the weight by which its *strength* is expressed.	Deflection of rail alone, under weight of eight tons.	Deflection of rail and string-piece combined, under weight of 8 tons.	Bearing surface, in square inches, resisting vertical pressure per running yard.	Surface resisting *lateral* pressure per lineal yard.	Surface resisting *longitudinal* pressure per yard.	Relative *virtual* bearing surfaces having respect to relative *stiffness* of rails.	Estimated cost of a mile of single track on each plan, by the same scale of prices.
New Jersey Railroad, T. rail,	38	59.71	52,800	2,728	63,360	—	4.21	—	.052	.099	—	45	4.7	.40	25	$10,700
Boston and Worcester, T. rail,	38½	60.5	52,800	5,280	50,483	—	4.21	—	.052	.099	—	34½	6.¼	.62	19	10,637
Baltimore and Susqehanna, H rail,	58½	91.93	—	16,044	50,688	77,088	12.6	—	.050	.032	—	29.7	3.6	.56	51	11,556
Stonington and Providence, do.	58	91.14	7,040	4,752	82,720	—	12.6	—	.050	.032	—	22.5	3.75	.62	39	11,149
Long Island, do.	56½	89.	5,632	5,280	61,600	—	12.6	—	.050	.032	—	24.	3.	.62	41	10,587
Boston and Providence, do.	55	86.43	7,040	4,752	36,960	63,360	10.32	—	.054	.042	—	24.	3.	.62	31	10,352
Baltimore & Ohio Railroad, do.	52	81.71	10,548	4,102	53,716	—	8.7	—	.055	.051	—	28.	4.	.62	31	10,354
Philadelphia and Reading, do.	45⅛	71.	5,910	5,005	55,174	81,574	8.11	—	.076	.075	—	26.9	4.	.62	20	9,451
Camden and Amboy, do.	45	70.71	6,600	2,237	60,555	—	7.65	—	.054	.056	—	19.	3.3	.62	19	9,114
New Castle and F. Town, do.	43½	68.35	1,056	2,259	62,480	—	7.65	—	.054	.056	—	18.	3.5	.62	18	8,736
Washington Branch, do.	40	62.86	9,856	2,112	95,040	—	4.97	18.47	.07	.122	.033	117.	5.	.80	51	9,519
Balt. and P. Deposite, square rail,	40	62.86	—	2,959	118,800	—	2.72	23.68	.118	.347	.045	90.	1.12	1.12	14	9,428
Wilmington and Susq'a, bridge rail,	40	62.86	11,668	2,816	57,200	—	4.58	—	.077	.135	—	26 4/10	5.25	.50	11	8,752
Projected bridge rail track,	45	70.71	5,940	3,696	77,778	—	6.12	13.12	.069	.090	.044	130½	2.13	.65	80	9,927
Do. Z rail,	45	70.71	1,509	4,736	67,760	—	8.	10.41	.035	.035	.027	63⅜	9.12	1.60	100	9,482
Do. do.	35	55.02	1,509	3,269	67,760	—	5.72	9.85	.060	.084	.050	63.	9.12	1.28	41	8,169

setts, the Norwich and Worcester, New Haven and Hartford, etc., have been necessarily omitted for want of specific information respecting them —but it is not believed that their introduction would materially affect the conclusion which the undersigned would draw from the comparison in hand. He has added to the railways of the several companies enumerated, a projected plan of a track in which a Bridge rail of 45 lbs. per yard, is exhibited, with a continuous bearing or string piece; and he designed this track (in which he believes the Bridge rail is perhaps shown as advantageously as possible) for special comparison with the proposed track, in which the Z rail is alike in weight.

The manner in which the several columns of the foregoing table have been calculated, may be sufficiently obvious without explanation, but it will not be amiss to offer some remarks upon the mode in which the 13th, 14th, 15th and 16th were obtained.

The 13th column contains the actual bearing surface of the rail, per running yard, in square inches, on the cross ties or string piece, or both, assuming an average breadth for the ties.

The 14th column shows the number (per yard) of square inches of surface in the timber supports, which resists the *lateral* displacement of the rail; and, in arriving at this particular, the method employed has been to multiply the breadth of each spike or bolt, (brought into action by the lateral push of the wheels) by half the distance to which it penetrates the timber, as in resisting a force applied at one end of and at right angles to it, the fastenings may be supposed to revolve upon the middle of that part of its length, which is grasped by the wood, and consequently only one half of that length opposes itself to motion *in the direction of the impelling force*, while the resistance of the other half is of the nature of a fulcrum of motion.

The 15th column exhibits the surface of resistance to *longitudinal* movement of the bar. In estimating it, this principal was proceeded upon; that the only *efficient* incorporation of the bar, with its substructure of timber, is an attachment of the requisite strength, either in the centre of the bar, where there is *no* movement of contraction and expansion in the iron itself, (and where the rail may and should be rigidly fixed if possible) or if at any other point of the bar attachments are introduced, they must be such, that on moving to and fro with the iron, in its process of longitudinal extension and shrinkage, from alternations of temperature, they will all the time retain their character of *points of resistance*. Now, the only way in which this last condition can be practically fulfilled, is to fix firmly to the *rail*, (so that no motion will exist between them) the bolt or spike, etc., which constitutes the fastening, and to let the movement of the fastening (during the contraction and expansion of the rail) take place *within the wood which it perforates*. And if this motion among the fibres of the timber is to so small an extent, as to leave their elasticity unimpaired by the intermitting compression to which they are subjected, then the perforation containing the fastening will not be enlarged, but will continue to grasp the spike or bolt firmly, and afford (in all states of the bar, as to temperature and length) the desired resistance to movement lengthwise of the track by the action of the trains. Now, in examining the attachments intended to provide against longitudinal movement, in the various rails of the table, it is found that (excepting those of the Port Deposit rail and Z rail) they consist of a fastening either in the middle or at the end of the bar, or at both of these points—where it is in the middle alone, it acts efficiently *to the extent of its surface of resistance*, or where it is at the end alone, it does the same, though permitting more opening of the points of the bars—

but where it is both in the middle and at the end, there is no assistance rendered by the latter to the former, excepting when the bar is at its utmost expansion by heat, at which moment alone, the two fastening will act together; and this is because the end fastening is not firmly attached to the *rail*, but *is* fixed fast in the *wood*, and room is left for the advance and retreat of the end of the bar towards and away from the fastening. For these reasons, I have allowed all the rails (excepting the two just mentioned) the benefit of but one point af attachment in each bar, in calculating their resistance to endwise movement. But the Port Deposit rail and the Z rail, whose fastenings are placed at regular distances apart throughout the entire length of the bar, have all those fastenings attached firmly to the rail, and moving with it under its changes of length; and at the same time they are held by the wood of the string piece with a resistance constant, but sufficiently yielding to permit the elongation and shortening of the rail. All of the attachments of those last rails are therefore permanently efficient, if, as it is believed,* the varying compression of the wood by the spikes and bolts, is not sufficient to destroy its elasticity. These rails are therefore, considered, as complying with the condition above expressed, as necessary to an effectual attachment of the bar to its substructure of wood, by a number of points, with a view to prevent endwise movement. It is true, now, that the H and the Bridge rails are capable of the same sort of attachments, for notches as frequent as may be wished, might be cut out of the feet of the rail, to embrace the shank of the spike. But such a resort would seriously weaken the rail at a every such point of attachment. And as the Z rail has also a foot which may be similarly notched to receive the spike, it would still be enabled to retain its present relative superiority, in regard to a resistance to longitudinal movement.

In the Baltimore and Ohio new track, the resistance to longitudinal movement is estimated by the strength of attachment of the *cross tie*, in the middle of the bar, to the *under sill*, (by means of the treenail) and not by that of the rail to the cross tie, because the former is the *weaker* fastening of the two, and if the bar moved, it would carry the cross tie with it, (as in fact it has done.) The resistance of the ballasting to the movement of the cross tie, is not counted as an aid; for the motion to be guarded against for the preservation of good joints, is so very small, that so loose a material as the filling of the traek, would be totally inefficient to check it. And herein is one reason of the *necessity* of an undersill, and the *advantage* of a string piece, which being closely butted together cannot move endwise; and thus give an abutment to the fastenings for retaining the bar from a similar movement.

The 16th column represents the *ratios* between the virtual or effective bearing surfaces of the several rails; derived from compounding their actual supporting areas with the numbers expressing their deflections under the same load. Of the correctness of this mode of comparison, there can, it is thought be no doubt, as the pressures upon the wood through the iron bars, are *longitudinally* diffused in precise proportion to the relative stiffness of those bars.

* The wood on each side of each bolt or spike hole, will be compressed to an extent proportional to its distance from the middle of the bar. For a rail of about 20 feet long, the movement of the end of the bar, (if confined at the middle) between the probable extremes of temperature, would be a full 12th part of an inch; and this bolt or spike hole would be compressed alternately on each side 1-24th part of an inch, which it would probably bear without permanent enlargement. This would be the *extreme* compression, however, the average being but the one half or 1-48th of an inch, which the wood might well sustain.

The stability of a railway track, like that of any other piece of framing or machinery, must be proportioned to the values of the resistances it presents to the several strains to which it is subjected. This being granted, as it must be, the undersigned feels himself warranted in appealing to the above tabular statement, as furnishing *demonstration* that the track which he has designed, is superior, in all the elements of stability, to any of its predecessors. In bearing surface to withstand *vertical* pressure, it is *twice* as well provided as the track which approaches nearest to it, and nine times better than the one which falls most short of it.

Its resistance to *lateral* movement, is $1\frac{1}{2}$ times that of the track which comes the closest to it, and 8 times that of the one most behind it.

In the counteraction of *longitudinal* motion, it is better than the best of its competitors by nearly 50, and than the worst by 400 per cent.

Now, that improvement in these particulars in the present structures is wanted, the experience of every railroad company must have taught. The best and most expensively constructed railways of the country, cannot be closely inspected without it being perceived, that the connections of their parts are too weak to withstand the action of their locomotive machinery. To a greater or less extent, in all those which have come under the examination of the undersigned, the wooden supports are crushed, the iron rails forced aside, and the joints either entirely closed or too widely opened. Spikes, bolts, and other fastenings frequently give way, and where the maintenance of an accurate adjustment of the track is aimed at, much expense of material and labor is incurred in replacing them; while the expedients resorted to, for restoring the deranged adjustments, cripple the timber, and convert the originally handsome structure into an unsightly piece of patchwork. There may be lines of railway, which have, in a measure, escaped these derangements; but has the trade and tavel upon them been as yet very trying?

There certainly cannot well be too much strength given to a rail track, provided a sufficient elasticity is preserved to relieve to a certain extent the concussions, which are destructive of the machinery. In this latter view, wood should be preferred to stone, as a support for the rails, although stone would afford theoretically the most strength in the connections.

In the 8th column of the table, showing the weight in tons that each rail will bear, it will be seen, that while the T rails of 38 lbs. per yard are quite weak, as well as the Bridge rail of 40 lbs. per yard, and still more the Square rail of the same weight (to which last, the string piece is indeed absolutely necessary) those of the H pattern, (9 in number) varying from 40 to $58\frac{1}{2}$ lbs. per yard, exhibit a great degree of strength for their respective weights—3 of them reaching $12\frac{6}{10}$ tons, and 1 of them $10\frac{1}{3}$ tons—4 of them from $7\frac{2}{3}$ to $8\frac{2}{3}$ tons, and the lightest of them 5 tons. It must be observed of these rails, that in estimating the strength by Barlow's rules, the whole breadth of the lower web was used in the calculation, although that writer intimates a doubt founded upon one of his experiments, whether in such sections, the outer portions of the base add much to the strength of the bar. Admitting, however, that they do (notwithstanding the professor's doubt) contribute fully as much as the calculation supposes, it is considered that it would be much better to submit to a reduction of strength in these bars, by removing some of the metal from the lower web, in order to strengthening with it the upper table, which is disproportionately light.* But then, as the breadth of base in these bars is not too great for stability,

* The English Engineers seem to be verging towards a preference of the Bridge section over the T and H sections, on account of the destructibility of the upper table of the latter forms of bar.

it could not be reduced without reducing also the *height*, and this again would diminish their strength and stiffness. It is true that the present apparent strength of these rails is superfluously great; a strength of 8 tons (which the Z rail has independent of its string piece, and 10½ with it) being all sufficient. No change, however, which could be made in the proportions of the H rail, as exhibited in the bars in question, would make its top as well able to endure the wear of the wheels as that of the Bridge rail. The latter indeed is neither so strong nor stiff a form of section, but as has been said before, will prove practically the best rail of the two, and between it, therefore, and the Z rail, the undersigned believes that the question lies. The superior strength and stiffness of the Z rail, then, suffering no drawback from the weakness of its upper table, which is as well or better supported than that of the Bridge rail, should it not obtain the preference, unless some other objections can be established against it, which overbalances its advantages in those particulars?

Here, then, appears the proper place to notice some of the objections to the Z rail, which may occur to others as they present themselves to the undersigned while maturing his plans.

It may strike those who examine it, that the dependence of the Z rail on the string piece for *lateral* support and maintenance in its upright position is objectionable. But when it is considered that on the string piece it is equally dependent for *vertical* support, like any other rail of continuous bearing on wood, the difficulty seems to disappear. The Z rail indeed *hangs* by its top on the inner edge of the string piece, just as the common plate rail rests thereon. The Z rail may, in fact, be regarded as an iron plating of the top and inside of stringer; as long as the latter retains its stability, so long will the former—and we know that the stringer of the plate rail track would stand very well, if it did not crush under the weights from which its thin bar protects it so poorly. But it will be said, that the Z rail does not bear on the string piece alone, but also on the cross tie. True, and if the latter bearing acted, or sustained the whole weight independently of the former, the string piece would then perform the office of a simple side support. This it would, indeed, be entirely competent to; but in fact it must of necessity bear the vertical pressure of the rail also, in consequence of the *intended* insufficiency of the tie, to sustain it unaided. The bearing area upon the tie is but 9 square inches per running yard of rail, a surface experimentally known to be too small to resist compression in the hardest woods we have.* Should, then, the bearing of the rail, through defective fitting of the parts in construction, be thrown at first on the tie, it will soon become compressed under the travel, so as to bring the top bearing of the rail on the stringer into action; and where the latter bearing is perfect in the first instance; but afterwasds withdrawn by *shrinkage of the timber*, the rail gradually indenting the tie as the stringer recedes, will follow the latter and maintain the constant harmony of the two bearings. This expected result depends upon such simple and obvious principles of mechanical action, that the undersigned cannot feel hesitation in his confidence of its occurrence. The amount of shrinkage in the string piece, will not exceed about ⅛ of an inch in extreme cases, and this much, the tie will assuredly compress. The cast iron plate at the joints, extends the tie bearings there, but not more than the rail requires from its greater weakness at those points.

There are, then, the best reasons to believe, that the rail and string piece will act together as a single beam, whose propoitional height and width

* The *locust* ties upon the new track of the Baltimore and Ohio railroad, when the bearing area is 28 inches per running yard, have all become more or less indented by the base of the rail.

and connection with its supports, will give it all the stability of position that can be desired. The string piece being fitted close and confined in the notch of the tie by a treenail, it is proposed to compensate for the small shrinkage of the former, by driving a thin wedge between it and the outer shoulder of the notch, so as to keep the gauge of the track from widening. Any other form of rail resting on top of a string piece, would equally indeed require this adjustment. The impression, then, that the dependence of the Z rail on its string piece is, in reality, greater than that of any other section of bar, supported by a continuous bearing, will, it is believed, be removed by reflection from the minds of those who may naturally recieve it from a slight examination of the subject, and their ultimate conclusion, it is thought, will be, that the Z rail holds, on the other hand, the best possible position with respect to the timber with which it is connected, and that it will suffer no more from the decay of the wood than will any other rail, upheld in any other manner by a similar material.

The 6th column of the preceding table, exhibiting the quantity of timber in each track, will show that the advantage of a very limited employment of wood, supposed to belong to the heavy class of rails, is not, in fact, realized by them; as with two of the most weighty and best laid of them, viz: the Long Island and the Stonington rails, there is employed from 60 to 80,000 feet, board measure, per mile—the average between which, would be come up to by the Boston and Providence, and Baltimore and Susquehanna rail, if they were furnished, like the other two, with an undersill. The able Engineers who planned these railways, have, in the two first mentioned, which were the latest executed, shown their approval of the use of about that quantity of timber (70,000 feet, board measure) per mile, and with much less, no stable construction can be effected, even with the use of the heaviest iron. The quantity of wood in the Z rail track is about 68,000 feet, being slightly within this limit. The projected track for a Bridge rail of 45 lbs. pr. yard, has 78,000 ft. Both of these rails have a continuous bearing upon string pieces, yet they average very little more timber per mile than the heaviest rails with detached bearings. In fact, there is a proportion, and that not an inverse, but direct one, which should be maintained between the weight of the rail, and of the frame work connected with it. Nor in giving a continuous bearing to the rail, need the quantity of timber be necessarily increased; for the undersill may be proportionably lightened and the number of ties diminished, if a string piece be employed. The existing prejudice against the string piece, founded on the idea that it encumbers the track with an extra quantity of a perishable material, must therefore give way, and the continuous timber bearing will come into permanent favor. If, moreover, the hopes now strongly felt, of extending greatly the durability of wood, by the application of the process of Kyan and others, be realized, the sole valid objection to the use of timber in railways will be removed and all its advantages be enjoyed without a drawback. Yet, as wood is destructible not by rot alone, but also by *wear and tear*, it will still be necessary to guard against these latter agents, by providing abundant surfaces of resistance to the several strains upon the framing, and the structure which best accomplishes this object will ultimately and justly be the favorite.

The undesigned now respectfully commends the subject of the preceding remarks to the enlightened judgment of those to whom he has addressed them. In treating of his own invention, he has necessarily, and as he hopes not altogether unprofitably to himself and others, been led into the discussion of several points of general interest respecting the construction of railway tracks, and this has extended his observations to a greater length than he designed. He cannot better conclude them than by an expression of the cheerfulness with which he will abide by the decision which the Civil Engineers of the United States shall pronounce upon the merits of the plan he has presented; and he asks the favor of them to communicate to him, as early as their leisure will permit, their individual views of its claims to favor and adoption.

BENJ. H. LATROBE,
Baltimore, December 10th, 1840. *Civil Engineer.*

STEAM ENGINES.—We have received a copy of the annual report of the canal commissioners of Pennsylvania. Among the documents threto appended, is the report of the superintendent of motive power on the Philadelphia and Columbia railroad, in which an engine built by Mr. Ross Winans, of this city, is spoken of in the most flattering terms, which applies not only to the particular engine, but to the class of engines built by Mr. Winans. We extract the following from the report: "In addition to the different engines of the ordinary construction purchased by the undersigned is one built by Ross Winans, of Baltimore, which, as well as others, was contracted for by a resolution of the board, previous to the date of my last report. The general principle upon which this engine is constructed, is similar to the one which, by the order of my predecessor, has been placed on the road near a year before my appointment. It is, however, entirely different in its proportions.

"This engine was constructed by special orders, as an experiment in the use of anthracite coal as a fuel to generate steam; and on trial, has met all my anticipations. It is very large and heavy, with more than double the power of any other machine on the road. It burns anthracite coal exclusively, and from the additional space of fire box, obtained by its increased size, has advantages in the use of that article, which is not and which cannot be possessed by any orther plan of engine. It is intended exclusively for the transportation of heavy trains of burthen cars. It will haul double the ordinary train, but owing to its great weight, must be run very slowly over the road."

We have understood that this engine rests its entire weight on *four propelling* wheels, each wheel supporting about the same weight as each one of the *two propelling* wheels of the largest class six wheel engines on the Philadelphia and Columbia road. The engine last built by Mr. Winans, and which we have before noticed, is still more powerful than the one spoken of in the report; but having overcome the difficulty that has heretofore been deemed insurmountable, of placing eight wheels under his engine, and connecting the motive power with all of them, so as to get the adhesion of the entire weight, without having a weight on any one wheel, which is oppressive to the road. The engine now furnished weighs 19 33-100 tons, when in running condition, and is mounted on eight propelling wheels, which divide the weight equally among them, putting 2 42-100 on each wheel. The passenger engines of Norris' construction, in such extensive use, weigh about 10 tons when in running condition, but as they have only two propelling wheels, the greatest adhesion which they can render available is that resulting from 6 70-100 tons resting on the driving wheels, which is but little more than one-third the adhesion obtained by Mr. Winans' eight wheel engine, while the weight on each driving wheel of the Norris is 3 35-100 tons, nearly a ton more than the weight on each wheel of the eight wheel engine. The power of every locomotive engine is limited by the greatest adhesion of its wheels on the rails; the adhesion is directly as the weight resting on the propelling wheels collectively. The greater the weight bearing on any one wheel the more destructive to the road. The greatest economy in transportation results from the use of the most powerful engines that can be employed, consistent with the strength, and character of the road, on which they are to run; hence the advantages of increasing the number of propelling wheels.

An account was published a few days since in a Philadelhia paper of a gross load of 481½ tons being drawn over the Philabelphia and Reading railroad by an engine built by Messrs. Baldwin, Vail and Hufty, the weight of which is stated to be 11 92-100 tons, and the weight on the driving wheels 6 30-100 tons. As this is less than one-third the weight on the driving wheels of Mr. Winans' eight wheel engine, which has been shown to work to the full extent of its adhesion, it follows that it would be capable of taking over the Reading road three times the amount of the load above named.

The report above mentioned states a fact which gives to Mr. Winans' engine great recommendation. It is with reference to fire from locomotive engines. Extract from the report: "But I am constrained to say, that I am now satisfied that public opinion has always placed a mistaken estimate on the security in engines, the fuel of which was exclusively mineral coal, against firing property in the vincinity of the road. One year's experience has settled that question in the mind of every one who has paid any attention to the subject. It is true, if all the engines on the road were constructed on the same plan as those made by Ross Winans, of Baltimore, with vertical boilers and tubes, or flues, and a constant or uniform draft, then there would be no danger from fire. But with the ordinary engine, the draft of which is created by the exhaust steam of the engine itself, there is nor can be no security against fire."

BALTIMORE MECHANICS.

In our paper of the 19th ult. we touched briefly on the ingenuity, skill and industry of the mechanics of Baltimore, and incidentally noticed the locomotive engine constructed by our townsman, *Ross Winans*, with a promise that, at a future day, we would give a more minute description of the machine, with its advantages over engines of ordinary construction. We now proceed to comply with our promise.

The engine is constructed with a view to adapting it to the purposes of transportation. Its weight, when in running condition, is nineteen and a third tons, equally distributed on eight wheels, all of which are driving or propelling wheels; hence the adhesion of the entire weight of the machine is made subservient to its tractive power. The boiler is of the upright description, with vertical tubes, is peculiarly adapted to the use of coal, has 650 tubes and 20 square feet of fire grate. The cylinders are 14¼ inches in diameter and 24 in stroke. A highly important feature of the machine is, that while it has eight propelling wheels and is admirably adapted to the traversing of curves of the shortert radius common on railroads, (say 3 to 400 feet,) it is simple, compact and permanent in its construction to a degree that would scarcely be deemed possible without an inspection of the engine; it having a decided advantage in this respect over the generality of engines in this country, having *one and two pairs of drawing wheels only.*

The appearance of the engine is remarkably plain, pleasing and imposing, while it is entirely without ornament, except the comeliness of its outline, and the superiority of its workmanship, which is of the very best description. Among the practical advantages which this engine has, compared with the best of others known to the public, are the following: The adhesion is double, and consequently the load taken, or the amount of business performed is double, while the weight on any one wheel is not more, and in most cases considerably less than any engine possessing half its power. Thus the expense of men in attendance on the engine and train is reduced to one half in proportion to the work performed and a relief is afforded to the road which will result in the diminution of its repairs. The unusual power of the engine and amount of work performed by the per day produces a material decrease in the amount of fuel required for a given amount of goods transported. The great weight and strength of the various parts of the machine, (which is permitted by the weight being equally distributed on so many bearing points on the road,) will manifestly diminish the repairs of the machine in proportion to its useful effect.

Again: this description of engine will enable roads with heavy grades to be worked with an efficiency which has not before been obtained, for reasons which will be manifest to engineers. The engine in question was constructed with particular reference to the character and purposes of the Baltimore and Ohio Railroad, with a view to affording that company the means of testing fully and practically on their road the great advantages which were expected to result from the employment of engines of such power, provided the weight could be equally distributed on eight *propelling* wheels, combined with a simple, permanent and practicable arrangement and mode of causing the engine to traverse the numerous curves of that road with the requisite facility and safety. This Mr. Winans has accomplished to a degree, which few, if any besides himself, believed possible until the engine was put on the road, so that little more, if any thing is desirable in that respect.

The several trips which Mr. Winans has made with the engine to Harper's Ferry and back with heavy loads, to ascertain whether all was as he wished previous to his calling the attention of the company to the subject, have, so far as they go, fully supported the most favorable opinions entertained in reference to the advantages and saving to result from the employment of such class of engines. Mr. Winans has now offered his engine to the railroad company, for the purpose of enabling them to test fully its properties, and to compare its advantages and economy in the working of the road with those of the several descriptions of the most approved plan of engines known in their employ, previous to the company's taking measures to procure the additional engines required on their completion of the road to Cumberland, which it is expected will be accomplished in the next eighteen or twenty months.

This offer of Mr. Winans the company will no doubt most cordially embrace, as it comes most opportunely to enable them to complete the comparisons between the most promising engines extant, which they have been pursuing for several years, to enable them to act understandingly in a matter of much importance to the successful and profitable working of the road as that of selecting the plan of engine best suited to its requirement.

NEW LONDON, NORWICH, AND WORCESTER RAILROAD.

We publish below the proceedings of a meeting of the citizens of New London, convened at the City Hotel on the 25th ult., for the purpose of conferrimg on the subject of extending the Norwich and Worcester Railroad to this city. We understand that in pursuance of the wishes of the meeting, as expressed by a vote, the Committee proceeded to Norwich, and had an interview with the directors of the company, by whom they were received with kindness and cordiality. In the course of a friendly and frank discussion of the subject, the directors gave the Committee to understand that they were not at present prepared to extend the road, but if, upon further trial, it should be found that the Road, as at present established, will not afford that accommodation to the public which it was designed to afford, they will then be happy to confer with the committee, and to meet the views of the citizens of New London as expressed in the resolutions published below.

The committee appointed by the meeting will continue organized, and our citizens may be assured, from the character of the gentlemen composing it, that they will be watchful of the interests of New London, in case that an extension of the road should become necessary, while they will avoid throwing any obstacle in the way of our Norwich friends, who deserve much praise from this community for their perseverance in bringing so near to perfection a work, which to us, as well as so the whole public, is even in its present state, of great and increasing value and convenience. We can assure our neighbors of Norwich that they have no unkind feelings to meet on the part of New London in perfecting the work at its present terminus, and it is only in case that this should be found impracticable that the citizens of New London would wish to move in the matter.

The inhabitants of the city of New London having convened, in pursuance of public notice, on Thursday, the 25th ult., at the City Hotel, for the purpose of conferring upon the subject of continuing the Norwich and Worcester Railroad to this city, the meeting organized by appointing Ebenezer Learned, Esq., Chairman, and George C. Wilson, Esq., Secretary.

On motion of Gen. Isham, the following resolutions were presented, and after being ably sustained by him and by Thomas S. Perkins, Esq., were unanimously adopted.

Whereas, it is understood by this meeting, that the directors and company of the Norwich and Worcester Railroad contemplate the extension of their road from its present termination in the city of Norwich, to some other convenient point upon the waters of Long Island Sound; and whereas, it is also understood, that the citizens of Norwich accede to the contemplated extension of the road, it is therefore

Resolved, That Messrs. Jonathan Coit, Francis Allyn, Charles A. Lewis, Noyes Billings, John Brandegee and Acors Barnes be and hereby are appointed a committee to communicate with the officers of said company, and to procure such information as to their plans and views in relation thereunto as said committee may be able to obtain, and to communicate such information to the inhabitants of this city.

Resolved, That this meeting do highly appreciate the enterprize and perseverance of the citizens of Norwich in thus far effecting the important work above referred to; and we do express our firm conviction that an extension of the road to New London will be advantageous to that city, as well as to this, and that such an extension would greatly increase the income of the company.

Resolved, That the gentlemen composing the above mentioned committee be requested to ascertain the necessary facts with the least possible delay, and if they deem it expedient, to proceed immediately to Norwich, Worcester and Boston, and that they be authorised to communicate to the officers of the Norwich and Worcester Railroad Co. and to such other persons as to the said committee may seem expedient, the above resolutions, with full assurances of a disposition on the part of the inhabitants of this city to co-operate in extending the road of said company to this city should said company propose so to do.

Attest, EBENEZER LEARNED, *Chairman*,
GEORGE C. WILSON, *Secretary*.

New London, Feb 25, 1841.

ACCIDENTS ON RAILWAYS.

To the list we gave last week of railways, the miles run, and accidents which have occurred, we have to add the returns of the following :—

The Great Western has run 29,200,000 miles, carried 1,520,000 passengers, without any accident, fatal or otherwise, to a passenger, from its opening, 2 years and three months.

The Brandling Junction has run 92,876 miles, and carried 617,000 passengers without any fatal, and only two trifling accidents, neither of which prevented the parties from going about their usual business, in 12 months, to the 5th instant.

The Bolton and Lehigh has run 223,480 miles; carried 674,870 passengers in $9\frac{1}{4}$ years, to the 15th September, with the following accidents :—one passenger, attempting to get into the train when it was starting, got his foot bruised; another, who had got upon a waggon going off with the train, was thrown off and had his arm injured; a third had a slight contusion occasioned by a collision; and a fourth was killed by jumping off a train going at full speed, in consequence, as it was believed, of his being intoxicated. The only accidents attributable to the railway are obviously the "slight contusion," and the iujured arm.

The Dundee and Arbroath, opened October the 8th, 1838, (now 23 months) has, to the 1st September inst., carried 378,043 passengers, (the miles run not stated) with the following solitary accident, namely, the breaking of the leg of a passenger who had, contrary to the regulations, got into the luggage waggon.

The Arbroath and Forfar was opened January the 3rd, 1839, (now 20 months) and has run 59,000 miles, and carried 175,000 passengers, to September 10th. One accident only has happened; that is, a passenger broke his leg by jumping off the train while in motion.

Thus are added to our former list, from these five railways, only one of which is a large passenger line, 3,365,000 passengers carried, and on four only of the lines 29,575,000 miles run, without one fatal accident, and only two slight bruises fairly attributable to the railways; for we repudiate all accidents which the drunken or headstrong ways of men, violating orders and rules, bring upon themselves. The account, therefore, will stand thus; about 256 millions of miles have been run, and 14 millions of persons carried, with only two fatal accidents from the railway system.

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 7, Vol. VI.
New Series. | APRIL 1, 1841. | Whole No. 379.
Vol. XII.

For the American Railroad Journal, and Mechanics' Magazine.

SOME REMARKS ON SUSPENSION BRIDGES, AND ON THE COMPARATIVE MERITS OF CABLE AND CHAIN BRIDGES.—*By J. A. Roebling, Civil Engineer. No 2.*

Storms are unquestionably the greatest enemies of suspension bridges. As to the action of the wind, however, upon these structures, there appears to be a diversity of opinion among Engineers. I will offer some remarks which are the result of observation and reflection.

Those who have had an opportunity of examining chain bridges, will know that it requires comparatively but a small force to put the chains and the whole floor in an oscillating motion, as they are suspended vertically, and will follow the laws of the pendulum.

Railings and longitudinal vertical trusses will not prevent these oscillating motions, but a stiff and well-constructed floor will offer a great resistance.

The floors of almost all the English suspension bridges are entirely too light; better specimens in this respect are to be found on the Continent.

When the force which sets a pendulum in motion is continued to be applied at regular intervals, which correspond with the oscillations and their directions, the effect will be a great extension of these oscillations. The scope of oscillations of the heaviest weights thus suspended and operated upon, may be very much increased. Forest trees which have withstood the effects of storms for ages, have only escaped the fate of other less fortunate individuals, because the gusts of wind never happened to correspond with the oscillating motions of their tops. Chance saved them. It is the same case with suspension bridges. When a high wind blows sideways against the floor and railings of a suspension bridge, an oscillating motion to a small extent will soon be produced. The irregular succession of gusts of wind, which but seldom will correspond with the oscillations of the bridge, will be the very means of stopping them; and thus many a bridge has withstood the fury of gales unhurt.

But suppose, while the bridge is oscillating to a great extent, another furious stream of air happens to strike it, just at the time it is moving in the same direction, the effect which then will be produced cannot fail to be destructive.

Thus, we see that a mere calculation of the effect of wind upon a body when suspended, will give a result far short of what actually may and has taken place.

Vertical currents of air may be, no doubt, as violent as horizontal currents; but the former will never do much harm to a well-constructed bridge.

The experience in suspension bridges was very limited at the time Mr. Telford displayed the power of his genius by the erection of the noble Menai. No provisions were made by him to secure the platform against the action of vertical currents, although the position of that bridge admits of the most effectual application of remedies which will never fail.

Mr. Brunel, jr., was the first who applied the proper means to guard against the effect of vertical currents, and to a certain extent also against side currents, in the construction of a suspension bridge on the Isle of Bourbon, where hurricanes are of frequent occurrence.—(*See Navier's Memoir sur les Ponts Suspendres.*) In this bridge the platform is held down by stages, fastened by the lower ends to reversely-curved chains, the ends of which are secured in the piers and abutments. Thus the platform is completely secured vertically. At the same time the ends of these reversed chains recede from the bridge horizontally, and act as diagonal stays in the latter direction.

The same expedient can be applied to the Menai bridge more effectually, as the floor is elevated nearly 100 feet above the water. This, together with strong cast iron parapets, and a better constructed floor, would no doubt insure the safety of this noble work for all ages to come.

Chains are suspended in vertical planes, and when put into a swinging motion, cease to offer a uniform support to the suspension rods.

Cables are, and should always be suspended in inclined, or rather curved inclined planes; but this cannot be done with chains. Herein consists one of the main superiorities of cables over chains.

The planes, in which the cables are suspended, being inclined towards each other, give at once to the floor a horizontal stability, especially at the middle of the bridge, where it is most needed. It requires a wind of great force even to displace a platform thus suspended, to any extent, and regular oscillations are next to impossible.

This principle of inclining the cables may, in situations exposed to frequent storms, be carried out to a greater extent than it has been. It is necessary, however, in such cases, that the cables should be supported by towers, and not single unconnected columns, as they have a tendency to thrust the latter towards each other.

The Friburg bridge is suspended by four cables of 5½ inches each in diameter. Two cables are placed on each side. There is, however, no practical difficulty in uniting any number of cables into one single cable, so that there may be but *one* cable on each side, to which all the suspenders on that side are attached. A single cable will be superior to a pair of cables when displaced by lateral forces. The arrangement of the cables in inclined planes is also rendered easier, when but one cable is formed, than when they are collected into pairs.

In order to increase the vertical stability of suspension bridges of a great span, it will be useful to bring the weight of the cables into action by connecting them with the floor at intervals, either by timbers or cast iron pipes, which may include the suspenders. The floor then cannot be raised at any place without lifting a considerable portion of the cables and of the whole bridge.

The greatest trial to which a suspension bridge may be subjected, next to storms, is the march of a body of soldiers, moving over it in regular file and step. A crowd of people, moving promiscuously, will not produce a strain so severe as the momentum of a much smaller body of men, the united weight of which is rising and falling at regular intervals. In the latter case, a regular vertical oscillation of the platform longitudinally will take place, and the momentum of the load will unite with the momentum of a great portion of the bridge, in producing shocks which greatly exceed the strain produced by a promiscuously moving load. Heavy railways and stiff connections between the floor and cables, and a stiff floor, will contribute much to counteract such effects.

Large bodies of troops, when moving over such bridges, should always be ordered out of step. Several accidents produced by the above cause are now on record.

The above remarks have not been made with a view of bringing suspension bridges into discredit. To impute such a motive to me would be unjust. No one can be a greater admirer of the system than myself. The superiority of these structures, and especially cable bridges, over all other kind of bridges, needs no argument of mine. Abler men have established this long ago.

In speaking of the weak points of the system, I have only intended to show how much caution is necessary in planning and executing a suspension bridge in order to insure perfect safety. It appears that the destruction of so many wooden bridges by the late freshets, would urge the adoption of a system which is beyond the reach of ice and floods. But, to insure the successful introduction of cable bridges into the United States, their erection, and especially the construction of the first specimen, should not be left to mere mechanics. No modern improvement has profited more by the aid of science than the system of suspension bridges. And we see that all the noble and bold structures of this kind which have been put up in Europe, were planned and executed under the immediate superintendence of the most eminent Engineers, whose practical judgment was aided by a rich store of scientific knowledge.

For the American Railroad Journal, and Mechanics' Magazine.

"DEPOTS AND GROUND FOR RAILWAYS."

Messrs. Editors:—You were good enough to call my attention to a correspondent at Chatham Centre, with the remark that he was an Engineer, but you were not at liberty to give his name.

It is to be regretted that your correspondent has not used his pen to advance the cause of Railways, instead of making an unimportant and incorrect criticism on the article in your paper of the 1st October, 1840, with the above caption.

I trust a plain statement of the cost of land, depots, damages, &c., for the Western Railroad, on which I have reason to believe he has been engaged, will put him to the blush, if he will read the last report, as well as the previous ones, on this important thoroughfare. I shall quote from the last report, to prove that I am correct in all the essentials of the article referred to. It is introduced as follows:—

"Few Railroad Companies, at the commencement of their works, are aware of the extent of ground required for the accommodation and cover of their engines, for their cars, workshops, wood and station houses, &c. The consequence is, in the outset the Directors secure but partial accommodations, and afterwards have to pay extravagant prices, when their power by the charter to take land for the purposes of the road, by appraisement, is exhausted by non-user. They are then at the tender mercies of individuals, who are generally as heartless as the corporation they have to deal with; and any advantage that can be taken of a 'soulless company' is considered fair, *although the construction of the road is the main value given to their property.*

"We are led to make these remarks from reading the reports of the Camden and Amboy Railroad Company, where the items of real estate, land, damages, for *the right of way and necessary ground*, is stated at $371,769, or $4,041 per mile."

The cost on several other roads is then noticed for "*depots and ground for ways*," varying from $2,000 to $7,000, with the remark, (which appears to have excited the ire and criticism of your correspondent): "The Western Railroad Company of Massachusetts, over the mountains and rocks of Berkshire, have paid at the average rate of $1,700 per mile, or above $200 per acre, taking the general width of railways, 4 rods, or about 8 acres." We ask, what average of $1,700 per mile?—of course the whole road. What general average width of railroads? Four rods.

Your correspondent makes some long shots, wide of the mark, when he states, "The Western Railroad is nearly as often 15 rods wide as 5 rods in Berkshire county—varying from ten to thirty acres to the mile."

This, however, let me remark, has nothing to do with the question; nor his subsequent remark, "I think, Messrs. Editors, that the actual cost of the land (land only) may be set down considerably nearer $2 per acre than $200."

Let us look into the truth of this assertion, from facts drawn from the "*Annual Reports of the Railroad Corporations in the State of Massachusetts for* 1840."

At page 54, treating of the cost, in detail, of the Western Railroad, for 54½ miles east of the Connecticut river, we find that "depot lands, for eleven stations, 20 acres, cost $5,543," (or $277 per acre.) Again, "land, damages, and fencing, including lands for changes of highways, expenses of reference, cost $89,023," or equal to $1,730 per mile, or above $200 per mile. To these items we have to add, for "depot buildings, including repair, shop and machinery at Springfield, aqueduct, furniture for station houses, and fixtures, $73,500," or $3,080 per mile.

Let me refer now to "the estimates of the cost of the Western Railroad *west* of the Connecticut river, for 62½ miles. What do we find at page 61? "Depot lands, at ten stations, $5,041, with land damages [right of way] and fencing, $89,458," or $2,220 per mile, instead of $1,700.

The Massachusetts report remarks, page 66 [which supports the doctrine advanced Oct., 1840], "In 1833 it was supposed that lands for depots would be given west, as it had been, in most cases, east, of the river; but the company were compelled to pay for this object"— ! ! ! — ?

Again, on the same page: "The present depot arrangements at Boston are found to be wholly inadequate * * "— "The increasing business at Springfield would also require considerable additions to the accommodations of that station beyond those already estimated for and provided."

In treating of the cost and estimate for the continuation of the Western Railroad from the New York State line to Albany, with reference to land damages and depots, the report says, pages 70 and 72:

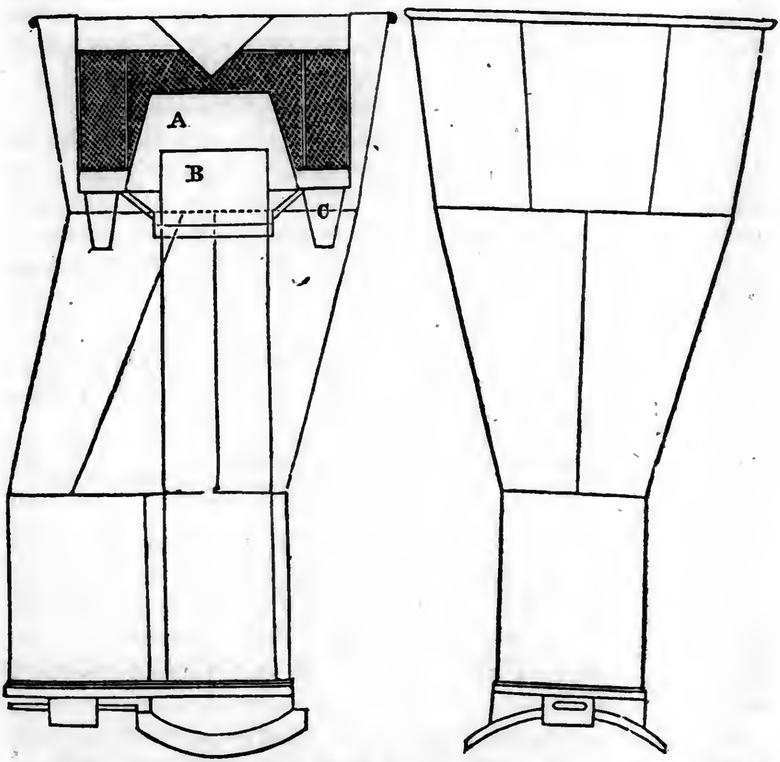
"On reviewing the estimates of the former Engineer, nothing is found included for the cost of purchasing and grading a depot at Greenbush, &c. The estimate for the *roadway* proved to be very inadequate."

The estimates (page 72) for "land, depots, and fences," for 38 miles, is stated to be $190,070, or $4,990 per mile; this does not include "the depot in Albany and steam ferry-boat, $65,000." Little is ventured in stating, that these estimates are much within expected payments, simply from the Albany and West Stockbridge Railroad not getting the right of way before they sold out to the Western Railroad, who put the road under contract, with hot haste, to occupy the ground, ere they had secured the titles on which to construct it. The article criticised was written to inculcate the doctrine, that it was necessary, as a step of the first consequence, in building railwrys, to get "*the right of way* and ground for depots," ere a company placed themselves "at the tender mercies of individuals." I also had the desire to add my mite, in aid of the valuable essay of William R. Casey, C. E., first published in your Journal of 1st Oct., 1839, on this subject.

In my remarks on "the Rocky Mountains of Berkshire," no disparagement was intended to that rich manufacturing county, by the introduction of its valuable rocks of granite and marble. That some of her rocks are sufficiently hard to make a road through of only two rods in width, we think some of the contractors will testify to. What your correspondent, or the Western Railroad, will do with 15 rods of land in width *for the roadbed*, in that or other regions, except to get dirt for embankments, we leave him to inform us. Certainly not 15 rods, nor are 5 rods necessary for the railway tracks, although 4 rods is generally taken; yet few roads occupy 3 rods. Where there are flats and high embankments required, it may be cheaper to buy 15 rods in width, to get earth, for short distances; but for the tracks of a railway, it is preposterous.

J. E. B.

There appears to be no greater desideratum in railroad machinery than an efficient spark arrester. The description of the invention of Mr. Daniel Matthew appears to satisfy this most important want; and, judging from the favorable notices in various quarters, and also from the experiments which are described, we cannot but consider that he has rendered valuable services to the travelling communities, as well as to railroad companies.



THE following statement is from a course of experiments made on the Utica and Schenectady Railroad with a new SPARK ARRESTER and CHIMNEY, recently patented by *David Matthew*, Engineer of motive power on said road, viz:

Two locomotive engines started with ten cars each behind the engine and tender, on the 4th and 5th days of February inst., with an open box two feet square, placed on the third car, or between 25 and 30 feet behind the tender, the bottom of which was covered with fine dry gun powder, and fluted in such manner as to prevent the possibility of the powder gathering in one place, the crevices in the bottom being all the time kept full.

1st Trial. Engine No. 2, run 30 miles before the powder took fire.

Engine No. 4, run 148 miles before the powder took fire.

2d. Trial. Engine No. 2, run 48 miles before the powder took fire.

Engine No. 4, run 115 miles before the powder took fire.

3d. Trial. Engine No. 2, run up and down the whole line of the road, being 156 miles, and did not set the powder on fire. The experiment was stopped in consequence of snow. The foregoing experiments were made with the powder all the time in the same exposed situation; weather clear and mild; the engines using hard and soft wood, and running at the rate of 20 miles per hour.

The above mentioned Chimneys and Spark Arresters are warranted to be equal as to draught to any open top, without any spark arrester, of the same diameter and length, and will not gum or clog up so as to stop the draught of the fire, either running or standing, as the subscriber has used the same kind on the U. and S. R. R. for nearly two years past.

N. B. The Chimneys and Spark Arresters mentioned above, and the right of using the same, may be had at the following rates, delivered in Albany or Schenectady: For a 14 inch pipe, $150, with the casing large enough to hold 12 or 14 bushels of sparks or cinders. Larger sizes in proportion, increasing about $5 per inch in diameter. Railroad Companies about to purchase, are respectfully invited to make a trial of the above Spark Arrester. Apply to

DAVID MATTHEW, *Engineer of Motive Power, U. & S. R. R.*

Schenectady, Feb. 10, 1840.

For the American Railroad Journal and Mechanics' Magazine.

COHOES, *February* 17, 1841.

GENTLEMEN :—

Having, by request of two gentlemen, been a witness of some experiments made by them to ascertain the loss in changing a rectilinear motion into an alternate one, or rather to ascertain the difference in the power required to move a body a given distance in alternate movements, I take the liberty to send you the results of the experiments.

It appears from the trials that a power that can move two pounds each four feet per second, one of which has a constant rectilinear motion and the other a reciprocal motion, can only move the two pounds in one mass in the latter motion $2\frac{66}{100}$ feet per second, and the single pound alone, moved in the same manner, only $5\frac{\text{[illegible]}}{10}$ feet per second.

It is believed the difference would exceed the above results were the apparatus more perfect.

It is proper that I should inform you why they were induced to make these experiments. They are the inventors of a rotary steam engine, in which the force of the steam acts constantly in a direct manner upon two rotary pistons; they believe their engine has an advantage over the reciprocating engine in consequence of the alternate movement of the piston of the latter; hence the experiments.

The gentlemen are William H. Baker and Samuel H. Baldwin. They are to renew the experiments as soon as convenient, with a more perfeet machine, when I will send you a description of the method of experimenting.

Respectfully,

CHARLES A. OLMSTED.

We are exceedingly sorry that so large a list of errors should be selected as the following from the late communication of Mr. Cushman—but in the first place, the "copy" was of the most intricate kind, full of complicated formulæ; and in the next place, Mr. C. is not particularly careful in distinguishing signs or letters resembling each other.

The proof was sent to Mr. C., and the Journal was delayed some time in order that we might hear from him, and we were at last obliged to go to press without receiving Mr. C.'s proof—but not until it had been carefully read three or four times in the office.

The communication we received from Mr. Cushman, together with the errata, is such as we cannot publish, and would not notice, were it not necessary to publish the errata themselves.

ERRATA.

Page 2nd, 26th line, "*expressed*" has been misprinted for expended.

7th	32nd	"	"(co z A—)"	"	(co z—A)
"	33d	"	"*revolution* of P"	"	resolution of P
34th	27th	"	"$\sqrt{1-\text{sine A}}$"	"	$\sqrt{1-\text{sine}^2 \text{A}}$
"	29th	"	"integration by *sines*"	"	intergration by series
35th	5th	"	"each *fraction*"	"	each function
"	6th	"	"*engines* which affect, &c."	"	signs which affect, &c.
"	11th	"	"$+ \cos z \cos z \frac{l}{2r}$"	"	$+ \sin z \cos z \frac{l}{2r}$
"	15th	"	"$-\sin^2 z^2 \frac{l}{4r}$"	"	$-\sin^2 z \cdot \frac{l}{4r}$
36th	6th	"	"2^2"	"	z^2
"	24th	"	"proportions"	"	proportion

Page 37th,	8th line	"$\frac{2r}{2}$=ton z"		$\frac{2r}{l}$= ton z
" 28th	"	"points"	"	pivots
38th	3d "	"($\frac{1}{2}\,l.\ \overline{1\ \cos\ z}$)"		($\frac{1}{2}\,l.\ \overline{1 - \cos z}$)
" 10th	"	"*cos*, as the value," &c.	"	or, as the value, &c.
"	17, 19 & 21	"points"	"	pivots
"	24th line	"2 and r"	"	m and r
" 26th	"	"to and *from*"	"	to and fro
40th	8th "	"points"		pivots

Our readers may remember that some time since we commenced copying a series of articles on the Steam Engine from the Am. Repertory. As they referred to articles inserted or copied into our Journal, we thought it best to give them entire, and when concluded to answer them. We soon found, however, that we were encumbering our pages to no purpose, and that no person of any pretensions to science would deem an answer necessary.

Several of the wholesale assertions of this writer have been taken up by various writers in the Am. Repertory. The annexed communication, which we take the liberty of copying from that Journal, is in answer to one of them.

We would beg leave to ask, however, whether this writer who labours so earnestly to deprecate the labors of our mechanics, is not himself a foreigner, with strong prejudices, and therefore not the most suitable judge among our own artisans?

GREAT WESTERN AND NORTH AMERICA.

The indefatigable writer "On the Steam Engine," whose peculiar ideas on the properties of steam occupy such a prominent and ample space in the pages of the American Repertory, having in the last number so far departed from truth as absolutely to assert that in the engines of one of the best steamboats on the Hudson River, "*only half as much effect is obtained from a ton of fuel as in those constructed on the other side of the Atlantic,*" I feel called upon to trouble its readers with a few remarks, to expose the absurdity of a statement evidently advanced for the purpose of inducing a belief that the gratuitous supposition of an existing ignorance of the advantages of expansive steam is really borne out by fact.

The foundations on which the bold assertien is made, that a given quantity of fuel is twice as effective in the Great Western as in the North America, are as follows:—"The Great Western consumes 28 tons of bituminous coals per 24 hours; the North America, 10 tons anthracite coals in 10 hours," (or 24 tons per 24 hours.) "The heating power of the fuel in each vessel" is next shown "to be very nearly the same; and it is further added, that "a trifling difference is of little value in our argument."—(See Repertory for January.)

The average speed of the two vessels on which the calculations are made, is, for the Great Western 8·5 miles, and for the North America 14·5 miles per hour; and the respective resistances, according to well known laws, are correctly stated to be in the ratio of 70·25 to 210·25, for equal sections, displacement, &c.; and further, the average displacement of the Great Western is estimated at five times that of the North America. On these grounds our acute writer exclaims: "Can we then doubt that the fuel is fully twice as efficient in the Great Western as in the North America?"

The assumed fact, that in consequence of the Great Western having five times greater *displacement* than the North America, the resistance of the former, at any given speed, will also be five times greater, I will suppose to be correct, in order to avoid a very lengthy demonstration, only observing that the average immersed midship section of the Great Western is four times that of the North America, and her superficial measurement less than 2½ times that of the latter.

The heating "power" (effect) of the fuel consumed in both vessels (28 tons bituminous coals in the Great Western, and 24 tons of anthracise in the North America) being stated to be alike, it follows that the effect produced in the former vessel ought to be twice as great as in the latter; or, in other words, that her engines ought to be twice as powerful in order to justify the assertion that "a ton of fuel in the Great Western is twice as effective as in the North America." A very short demonstration will convince the reader of the utter fallacy of this assertion.

The resistance opposed to the progress of the North America being to that of the Great Western, for equal displacement, section, &c. as 210 to 70, owing to the difference in speed; and their respective displacements being as 1 to 5, it follows that the *relative* resistance of the Great Western will be $5 \times 70 = 350$, and that of the North America 210. But the latter vessel will pass over a space of 14·5 miles, whilst the former passes over 8·5 miles. Hence, the relative force necessary to be exerted *during equal periods*, will be, for the Great Western $8{\cdot}5 \times 350 = 2975$, and for the North America $14{\cdot}5 \times 210 = 3045$. Thus proving that the power of the North America's engines absolutely exceeds that of the Great Western, and also that the consumption of 24 tons of anthracite coals in the former actually produces a greater effect than 28 tons of bituminous coals in the latter! With such a result, deduced entirely from his own premises, our profound writer "On the Steam Engine" assures the readers of the American Repertory that the North America, which he styles "one of the proudest achievements of American engineers," is so defective that only one half the effect is produced by a given quantity of fuel, as compared to the Great Western!

I forbear to animadvert on the loose reasoning which has led to such erroneous conclusions on a subject of grave importance; though I cannot refrain from observing, that the pompous style forms a striking contrast to the unsoundness of the views expressed; and I may be permitted to express an opinion, that the readers of the American Repertory would be benefited in a much higher degree by the many important practical facts communicated by the industrious writer "On the Steam Engine," if they were altogether unaccompanied by his comments. J. E.

New-York, 20th January, 1841.

A PROSPECTIVE VIEW OF PENNSYLVANIA IN RELATION TO HER SYSTEM OF INTERNAL IMPROVEMENTS, WITH SPECIAL REGARD TO THE PROPOSED PHILADELPHIA AND PITTSBURG RAILROAD.—NO. 1.

In these days of commercial gloom and prostration of business, it behoves us to look calmly at the resources which are at our command to repair our sunken fortunes, and on which we can mainly rely for the stable basis of our future national welfare.

As an agricultural district, Pennsylvania certainly ranks high, but can, in the nature of things, never become as important as some of the Western States will in the course of time. We have good soil enough to support a large population, but we never will have much to spare after supplying our home market.

As a commercial State, we cannot boast, to speak the truth, of occupying a very enviable position; some of our sister States have great advantages over us in that respect, and it is vain to deny it.

What great source of wealth is then left to Pennsylvania above other sections of the Union? We answer, *her immense mineral wealth, and consequent facilities for manufacturing.*

The mineral resources of Pennsylvania cannot be easily over estimated, when we look at the immense wealth which Great Britain has amassed by properly developing her resources, and thus making the wants of other nations subservient to her interests. The position in which England now stands to almost the whole of the globe, Pennsylvania is destined to assume, at least relative to the Continent of America.

To show what an important bearing a judicious improvement system has upon the success of mining and manufacturing operations, we need only point to Great Britain. The unparalleled progress of that country is to a very great extent owing to its facilities of intercommunication. Good turnpike roads, canals and railroads, are looked upon as the artificial arteries of a country through which the products of industry are flowing in all directions.

Distances have been and can still more be reduced by the application of steam. The improvements in railroad and locomotive engines will, it appears, contribute as much to the advancement of our country as all the other improvements of a modern origin together.

Let us complete our Erie Extension and North Branch Canals, which, when finished, will both contribute largely to the successful development of our resources, and will enable our improvements to pay for themselves.

The particular attention of our readers, however, is here called on to take into due consideration the vast importance of establishing a continuous line of railroad from our eastern metropolis to the Birmingham of the west.

The Columbia, Harrisburg, and Lancaster Railroad, form a continuous line to Harrisburg, a distance of 106 miles; 242 miles remain to be constructed from Harrisburg to Pittsburg to make the connection complete between the Delaware and the head of the Ohio river, at a total distance of 348 miles; and this can be accomplished at a moderate expense, not exceeding the average cost of good railroads in the Eastern States, and *without a single inclined plane*, and no grades exceeding 45 feet per mile.

We feel it our duty to dwell upon this important matter at some length, and to endeavor to make the citizens of Pennsylvania, and especially those of Philadelphia and Pittsburg, aware of the highly interesting fact, now established by actual survey, *that within our own borders, and nearly through the centre of the State, a route for a continuous railroad exists which can boldly challenge all the other States in the Union, without a single exception, and which can successfully compete with all rival routes which have already been established, or may yet be between the tide of the Atlantic Ocean and the Mississippi Valley!*

By the citizens of Philadelphia this important news ought to be hailed with joy, as by this fact, if the advantage is taken in time, the current of trade may once more be turned in their favor, and may be made to flow permanently.

It will be remembered that during the extra session of 1839, a law was passed and the sum of $30,000 appropriated for the purpose of making surveys for a continuous railroad from Harrisburg to Pittsburg, and Charles L. Schlatter, Esq., was appointed to conduct these surveys. A further sum of $15,000 was granted by the next legislature, and the report of the engineer is now being published.

Being fully awake to the important influence which the improvement system of our Commonwealth has exercised upon our commerce and industry in its present infant state, and will continue to exercise still more when properly developed, we have watched these movements with an intense anxiety.

We were aware of the popular opinion which then prevailed to a great extent, and was even countenanced by some engineers of standing, that no continuous route for a railroad could be established within the borders of our State, of a reasonable length, without resorting to inclined planes and other objectionable expedients. We entertained these apprehensions ourselves, to some extent, and were therefore most anxious for the result of these extensive surveys, which it appears have been carried on in a systematical manner ever since 1839.

So much greater was our surprise when we learned by the late report of the Canal Commissioners, that not only a route for a continuous railroad from Harrisburg to Pittsburg, had been found entirely practicable without any inclined planes, but that the distance and grades are far less than the most sanguine could have anticipated. We say now, that we have just cause to congratulate ourselves upon a discovery, which, if it be pursued at an early period, will in its train of consequences bestow benefits upon our community of the most durable kind.

But we imagine we hear many exclaim, "How visionary, how impracticable at the present time!—another internal improvement bubble—and such a gigantic undertaking!—two hundred and forty-two miles of railroad, which, when estimated at the actual average cost of our well constructed eastern railroads, will require about eight millions of dollars to complete and put in running order! The State already in debt too deeply, and here comes up another mad scheme, calculated to plunge us eight millions deeper!"

We hear all these objections, and have duly considered them before we formed our conclusions. But we entreat you to reflect calmly before you decide—and at the same time, we appeal to your *patriotism as Pennsylvanians.*

The matter which we present to your consideration, fellow citizens, cannot be urged in terms too strong or too expressive. A longer disregard, we apprehend, threatens to injure the future prosperity of a large portion of our State, and of our commercial metropolis in particular. We solicit your full attention, not to phraseology and exclamations, but to matters of fact, with which alone we pretend to deal in thus appealing to you.

Can we look on calmly any longer and see how Baltimore is striving to bring her harbor within twenty hours reach of Pittsburg, by the Baltimore and Ohio Railroad? The whole line of this important work is now constructed or under contract as far as Cumberland. A few years more, and that enterprising company will have finished a continuous line to Pittsburg and a branch to Wheeling. Philadelphia will then see, that the whole of her winter trade and the greater part of her spring and fall goods, and three-fourths of all the travellers will take their way from Pittsburg to Baltimore, and vice versa, instead of following the old accustomed channel to Philadelphia.

The completion of the Tide Water Canal, has already turned a large portion of our internal commerce in favor of Baltimore. This was the natural consequence of an artificial cause, and we cannot prevent it, since that cause is established on a correct principle. But since we have it in our power to call forth other agencies, which will work wonders in our favor, it is but onr own folly, if we allow our rivals to crush our interests by their greater sagacity and foresight.

It is not the mere effect of the propensity of acquiring filthy lucre, which makes nations rival each other in commerce and industry. The philanthropist and philosopher takes a higher stand, in viewing the active strife thus carried on honorably between different sections of a common country, and between distant nations and climes. It is the activity of commerce and industry, and the constant intercourse in consequence of it, by which the dormant faculties of mankind are called forth to act, and contribute largely to advance the cause of humanity, and develope the infinite resources of rational enjoyment and gratification.

It will not do for Pensylvania to stay behind the age of enterprise, and to wait till it is too late to commence. We all know how difficult it is to divert a trade from an old accustomed channel, where it has been fostered for years. And we also know, with certainty, that the population and consequent business will not decrease, but increase in a certain, though moderate ratio. Our communications should, therefore, be planned with a view to the future, and the revenues to be expected may be justly anticipated to increase in proportion to the rising population.

NORRIS'S LOCOMOTIVE ESTABLISHMENT.

We have the pleasure, this morning, through the kindness of Mr. Norris, of presenting our readers with an account of his extensive establishment for the manufacture of Locomotive Engines.

The factory of Mr. Norris is situated on Bush Hill, a little north of the Columbia Railroad. The ground occupied by the buildings is computed, in the aggregate, to be at least an acre and a half. The buildings are separated by Schuylkill Sixth street, which runs through them. On the east side of the street is the main building, with the blacksmith shop brass casting, and file cutting establishment; and on the west side is the carpenter's shop, pattern maker's shop and boiler house, to the latter of which is attached a blacksmith shop. The buildings are rather irregularly situated, but the establishment combines within itself every facility for the performance of work.

The main building is about one hundred and fifty feet long, by forty wide. On the first floor, a track is laid down on the south side, and here the engines are put together. Along the northern side, benches for the workmen are ranged. At the western end of the room, are lathes of every description, all of them driven by steam, and so arranged by machinery, that they require but little attendance after being once set. Some of them are of very ingenious construction; and we regret that our limited space will not permit a particular description of them. In this room were some truck frames. They are composed entirely of heavy wrought iron, and are specimens of great skill and neatness in forging. The machinery in this building is driven by a steam engine, which is placed in the cellar. The steam power is carried a considerable distance across the street, and into the boiler house, where it is used to drive a boring mill and punching machines.

In the second story, a busy and enlivening scene was presented—the room being filled with workmen engaged in preparing the various parts of the engine. The workmen's benches are arranged round the sides of the room, and down the middle. A large quantity of work was in a state of forwardness, while the number and variety of tools in use was immense. This is called the finishing room.

In the third story, the lighter parts of the work are performed. In both the last named rooms, we saw some beautiful specimens of work, both in iron and brass. To the south of this building, is the foundry for brass castings, and the file cutter's shop. In the yard is a powerful engine, worked by steam, and having attached to it a large reel of hose, so that, in case of the occurrence of a fire, it can be promptly extinguished. Running in a parallel line with the main building, is the shop where the engines, after being put together, are tried, so as to insure their being perfect, before sent away. Near this is the blacksmith shop, said to be one of the best in America. The number of forges in constant operation is twenty-seven; and at one of them, the frame of a locomotive was being forged. It is one of the improvements of Mr. Norris, that the frames of his engines are made of heavy wrought iron, in one piece. The forging of them is very difficult indeed. There will, in a short time, be erected here a trip hammer capable of faggoting a bar of iron six inches in diameter. The blacksmith shop has a front both on Sixth and Fairview street, and is admirably constructed for the admissin of light and air, as also for the immediate escape of smoke. In a room to the north of this are very heavy lathes, for the turning of wheel tires; and also a horizontal lathe, for boring the centres of wheels, as also the eccentrics for driving wheels. Mr. Norris is about putting up a stationary engine, for the purpose of driving the whole of the machinery of the establishment by steam, as also by means of the fan, to furnish blast for the forges.

On the west side of the street, on the first floor, is the carpenter shop, where all the wood work necessary for an engine is made, as also the heavy frames for the tenders. In the second story is the pattern shop, and here we saw a diminutive locomotive engine, complete in every particular, and capable of drawing five tons on a level road. It is intended for the Royal Conservatory at Berlin. It is, even to the smallest part, an exact copy of the larger class. From this room we passed into the boiler shop. This room is of large dimensions, and is filled with boilers in various stages of forwardness. One of them, intended for an engine which is to go to Berlin, was made of copper. Around the room, forges are placed at convenient distances, for the purpose of heating the boiler rivets, or any other part of the boiler which may be necessary. Attached to this is a blacksmith's shop, but the work done in it is exclusively for the boiler shop.

The work done at this establishment has a great and justly acquired reputation. Not only in our own country, but throughout Europe, the name of Mr. Norris has been made known, and his engines tried. From the period of the establishment of this factory, Mr. Norris has made and sent off one hundred and forty-two engines; and of these there have gone—

To Germany,	2.
To Austria,	5, and 2 yet to go.
To Prussia,	7, and 10 yet to go.
To England,	16.
To Cuba,	7, and 6 yet to go.
To Canada,	1.

The number of workmen now employed is three hundred; but there is ample room for four hundred and fifty. It is calculated that, independent of the boiler, they can complete an engine in seventeen working days; and in the ordinary course of work, can perform *all* the work required on an engine in the space of one month.

The veiw of this factory has afforded us unmiugled pleasure. Extensive as it is, it shows us but an example of what individual enterprise can accomplish. Establishments of this kind are a credit, not only to the city in which they are located, but also to the State, and should be supported by all who have at heart its honor and well-being.

PROGRESS OF CIVIL ENGINEERING.

Account of Dircks' Patent Improned Metallic Railway Wheels with Wood-faced Tyre, read by MR. HENRY DIRCKS, *before the Mechanical Section of the British Association, at Glasgow, Sept.* 19, 1840. *And also before the Polytechnic Society, at Liverpool, Oct.* 8, 1840.

As an introduction to the observations immediately relating to the improved wheel which is the subject of the present communication, a few preliminary observations may serve to make its nature and advantages more generally understood.

Wooden wheels were originally in common use on railways; these were afterwards superseded by the extensive use of cast iron wheels; and both of these descriptions of wheels were much improved by manufacturing them with wrought iron tyres. Modifications of these wheels are still in use on the Liverpool and Manchester Railway, the wooden wheels having the nave of cast iron, and the spokes and rim of wood, the tyre being of wrought iron. On the London and Birmingham Railway, cast iron wheels are extensively used. On the Continent of Europe, and in America, cast iron wheels are seemingly employed by preference; and are no doubt quite as safe for travelling, where great speed is not practised.

In England, a decided prefereuce is given to wrought iron wheels, in which this metal is used throughout, with the exception of the boss being *cast* around the ends of the spokes. The latest improvement on these has been the making of the entire wheel, including the boss, of wrought iron.

The wheels now in general use derive their chief novelty from the construction and placement of the spokes, with a view to obtain elasticity, strength, and durability. One variety which does not come under this denomination, is the plate wheel, supposed on its introduction to possess some peculiar advantage in overcoming a supposed resistance of the atmosphere. Except, however, in relation to variations in size, the present wheels are little more than varieties in pattern. The common diameter of carriage and wagon wheels is three feet, and the largest driving wheels for locomotives are those employed on the Great Western Railway, being six or seven feet in diameter, though at one time they were made as large as ten feet.

The action of an iron wheel on an iron rail, though derived from a rolling motion, can only be compared to a series of blows, and the rebound occasioned by iron striking iron is well known to be considerably greater than is produced by striking wood on iron. To this simple fact we may trace the tremulous motion occasioned by iron wheels on an iron railroad; and when, by any trifling accident, as an inequality from the rising of one end of a rail, or sometimes even from small flinty pebbles getting on the rail, the rebound is not more fearful than dangerous. The tremulous motion of the rail just adverted to renders it necessary in most cases to lay the rails on wooden sleepers. As an illustration of what is meant, it may be mentioned that on the Dublin and Kingstown Railway the rails were originally laid on granite sleepers, but the tremor was so great as to loosen the rails, and occasion serious fears from the consequent damage sustained by engines and carriages passing along the line. It was, therefore, ultimately agreed to take up the granite and lay down longitudinal wooden sleepers, a work of considerable labor and expense. In some cases the nature of the soil or sub-soil may allow the use of stone blocks; and where they can be applied with safety, they are preferred, for the reason that a road laid on *stone* blocks can be kept up at a lower rate than one laid on *wooden* sleepers; and, as has been endeavored to be clearly shown, the only reason for laying the stone aside, arises from the tremor imparted to the rail by iron wheels as at present used.

We shall now proceed to a description of the improved metallic wheel with wood-faced tyre, showing its advantages in connection with the preceding observations. The construction of the wheel may be understood by imagining a spoked wheel with a deep channelled tyre. The wheel may be made either of cast or wrought iron, it having been ascertained that tyre bars can be rolled to the required pattern. In this channelled tyre are inserted blocks of African oak, measuring about four inches by three and a half inches, solidified by filling the pores with unctuous preparations; thereby counteracting the effects of wet by capillary attraction,—to which, by this means, it becomes impervious, and at the same time is not liable to unequal contraction and expansion. The blocks of wood are cut to the requisite form to fit very exactly in the external circular channel of the wheel, with the grain placed vertically throughout, forming a complete facing of wood. There are about from twenty-eight to thirty of these blocks round each wheel, where they are retained in their place by one or two bolts passing through each, the two sides of the channel having corresponding holes drilled through them for this purpose; the bolts are then well rivetted. After being so fitted, the wheel is turned in the usual manner. The wheel, when finished, has all the appearance of a common railway wheel, but with a rather deeper rim, the tyre faced with wood, and the flange of iron. Woods of various qualities may be used, whether hard or soft, requiring different chemical preparations according to their porosity, and in some instances requiring to be compressed.

The several advantages which this wheel possesses, are—

1. That the wood facing will wear a considerable time without requiring any repair.

2. That the wood can be refaced, by turning it up again in the lathe, as practised with worn iron tyres.

3. That the tyre can be refaced with wood at little expense, and at a far less loss of time than usual. In the operations of re-facing these wheels, or putting in new wood, the work can be performed without the labor and cost of renewing the wheels from the axles, which in the keying and unkeying is known to be very troublesome.*

4. That in regard to their working, it is the opinion of practical engineers, confirmed by actnal experiment, that they will work smoother, easier, and, as some have expressed it, more "sweetly" than iron-tyred wheels; with the advantage of going well in wet weather, even upon inclines,—having sufficient adhesion to the rail, without dropping sand to assist them in this respect, as practised when iron wheels are used.

5. That another and very important result will be, that the rails themselves will suffer less wear by using this kind of wheel, and that the fastenings, sleepers, and blocks will receive considerably less injury, and thereby favor the laying of railroads on stone blocks, wherever they are considered to be most desirable.†

A metalic wheel with a wood-faced tyre, which is the principle of this construction, obviates most, if not all, the difficulties which have been experienced, whether in the use of wooden, cast iron, or even wrought iron wheels. Cast iron wheels may, indeed, now be considered not far short of being equal to wrought iron wheels, for safety and durability, with all the superiority of which the application is susceptible. They are also neither clumsy nor inelegant in form, and are capable of being made to any pattern, even for carriage wheels for common roads. It may, therefore, very possibly occur that they will have the effect to bring cast iron wheels into as general use and as much reputation here as on the continent. This new construction and simple adoption of wood makes excellent driving wheels for locomotives; it may be readily stopped, by using a cast iron brake, and does not undergo that wear, which might be expected from the friction it then has on the

* As in every thing affecting railways, it is a desideratum to decrease the expenses as much as possible, it may here be mentioned that three feet cast iron wheels, with wood-faced tyres and wrought iron axles complete, can be made much cheaper than the generality of wheels.

† On lines situated like the Greenwich Railway and the Blackwall Railway, wood-faced wheels would diminish much of the noise which at present is a source of general complaint.

rail. The wood, by use, becomes exceedingly close and firm, acquiring a surface not easily distinguishable from metal in appearance.—*Civ. Eng. & Arch. Jour.*

Specification of a Patent for a new Combination of Ingredients to be used as a Substitute for Oil, for Burning in Lamps; granted to Isaiah Jennings, *city of New-York, December 31st,* 1839.

To all whom it may concern, be it known, that I, Isaiah Jennings, of the city of New York, have invented or discovered a new combination of ingredients to be used as a substitute for oil and other combustible ingredients, for burning in the various kinds of lamps now in use; and I do hereby declare that the following is a full and exact description thereof.

In the process of distilling whiskey for making alcohol, or high wines, it is now the practice with some distillers to commence the operation by subjecting the whiskey in the still to a much more intense degree of heat than heretofore, and as the progress of rectification proceeds to lower the fire to the ordinary temperature. The effect of this high temperature is, in the first instance, to drive over a liquor possessed of peculiar properties, intimately related to those of the essential oils. The quantity of this liquor obtained from different parcels of whiskey will differ, but I think that it will vary but little from two or three gallons to the hundred gallons of common whiskey. Its specific gravity is the same, as nearly as may be, with that of spirits of turpentine, and its reaction is, in many cases, similar. It is extremely high flavored, and brings over with it all the highly odorous matter contained in the whiskey, and has, consequently, an offensive smell. The reason for adopting this process by the distiller, is, that by driving over this oil, or spirit, which I shall designate by the name of *oil of whiskey*, the trouble and loss consequent upon rectification by charcoal, are avoided, and an equally pure spirit is obtained.

I have been thus particular in the foregoing description, as this peculiar kind of oil or spirit possessess the property of rendering alcohol and spirits of turpentine capable of combining with each other in proportions in which they do not combine when it is not present; and will also cause spirits of turpentine to combine with whiskey, or ordinary proof spirit.

In making my new compound, the spirits of turpentine may be the predominating ingredient, which cannot be the case when the compound of this spirit with alcohol is used alone. The proportions may, of course, admit of some variation, but the following is preferred. Two parts of spirits of turpentine; one of alcohol of 93° above proof, and one of oil of whiskey. Should alcohol of higher proof be used, the proportion of spirits of turpentine may be increased, but this is not deemed desirable. Tne advantage derived from this oil of whiskey is such, that were it not added, as above, the alcohol must exceed the turpentine in the proportion of about five to one.

I sometimes combine the oil of whiskey with sperm, or other oil, with turpentine, and with alcohol, or with the sperm oil alone;

which last combination will take place in any proportions. When I use the four ingredients I prefer to take about four parts of the oil of whiskey, one of sperm or other oil, one spirits of turpentine, and one of alcohol.

The fluid which I have denominated oil of whiskey, has, heretofore, been thrown away as worthless, but I have, as aboved stated, applied it to a highly useful purpose, and obtained a combustible fluid affording a brilliant light, at a cost far below that of the ingredients now in use, and which, when combined, as above stated, has not its offensive smell developed, but burns without odour.

What I claim as my invention or discovery, in the above named combination of ingredients, is the use and employment of what I have denominated oil of whiskey with spirits of turpentine, alcohol, or lamp oil, in the manner, and for the purpose, herein set forth.

ISAIAH JENNINGS.

In July, 1839, an article was brought to us for examination under the name of "Oil of Rum," which appears to be the same substance, so ingeniously applied by Mr. Jennings. A few experiments satisfied us that it was not, as had been supposed, impure spirits, but rather an oil containing a small quantity of alcohol, and perhaps water. It is also exceedingly pungent; sufficiently so to scent a large apartment when a vial containing a few ounces was opened for a short time. The taste was quite as fiery as that of alcohol. By some accident it was tried in a spirit lamp, and found to give a great heat, and in the proper management produced no smoke. It appears that the present mode of distillation has led to the discovery of a separation of this oil, and it is not improbable that its uses may be greatly extended, while its absence from the spirits will greatly improve the quality of the latter.

The following article on the same substance contains much interesting information.—[Ed.]

On the Potatoe Spirit Oil of the French Chemists. By JAMES APJOHN, *M. D., M. R. I. A., Professor of Chemistry in the Royal College of Surgeons, Dublin.**

In December, 1838, I received from my friend Mr. Scanlan a specimen of an oily fluid which had been given him by Mr. Bowerbank, an eminent London rectifier, and which the latter gentleman had found in small quantity in the faints or weak spirit drawn off towards the close of the rectification of common whiskey. Shortly previous to this time, Mr. Coffey, the inventor of the celebrated patent still, had observed the same substance at the extensive distillery of Sir Felix Booth; and upon coming over to Dublin, and visiting the establishment of Mr. Busby at Blockpitts in this city, Mr. Scanlan had the satisfaction of recognizing this same oil in the faint vessel, constituting a thin stratum resting upon the surface of the remainder of the fluid.

* Communicated by the Author.

The oil obtained from Mr. Busby's concern had a reddish-brown color, owing to dissolved vegetable matter, and its specific gravity was ·8401, that of the faints on which it rested being ·9269. Shaken in a graduated tube with an equal bulk of water, its volume was reduced 20 per cent., and the water upon distillation yielded alcohol. To insulate the oil, therefore, the following method was adopted.

The fluid obtained from the faint receiver was first washed with an equal bulk of water; then shaken in a bottle with an equal weight of pulverized and anhydrous carbonate of potash, and finally distilled from a glass retort, the condensation being effected by Liebig's tube refrigeratory. It began to boil at 262°, after which the temperature rose gradually until it became 268°, at which it continued until the whole of the oil was nearly over. The fluid first drawn off was set apart, as still containing alcohol, and that alone reserved for further purification which distilled over at 268°. This portion was redistilled. The ebullition commenced a little over 267°, and in less than a minute rose to 268°, at which point it continued until the rectification was nearly completed. The first and last portions being rejected, the middle portion, or that which came over 268°, was set apart for experiment.

The oil thus procured is a perfectly colorless liquid, destitute of all viscidity. The specific gravity is ·8138, and, as has been already observed, it boils steadily at 268°; cooled to —6°, it does not congeal. With rectified spirit it is miscible in all proportions, its specific gravity being thus augmented, and its boiling point lowered. It is immiscible with water, but nevertheless, when agitated with this liquid, it absorbs an appreciable quantity of it. It has a pungent and peculiar odor, and a sharp, biting taste, somewhat similar to that of the oil of cloves. When gently heated it readily takes fire upon approaching to it a lighted taper, and burns with a clear flame, unaccompanied by smoke. It is an excellent solvent for the fats, and also for resinous substances. Camphor, for example, is readily dissolved by it; and the same may be said even of copal, if a gentle heat be applied. Potash is taken up by it in considerable quantity, oil of vitriol gives it a crimson color. To determine its composition the following experiments were made:

(1.) 4·24 grains of oil burned in the usual manner with oxide of copper gave of water 5·06 grains, and of carbonic acid 10·42 grains.

(2.) 7·71 grains gave of water 9·22 grains, and of carbonic acid 19·12 grains.

(3.) 6·63 grains gave of water 8·05 grains, and of carbonic acid 16·26 grains.

The following are the results deducible from these experiments:

	(1.)	(2.)	(3.)
Carbon	67·96	68·59	67·84
Hydrogen	13·25	13·28	13·48
Oxygen	18·79	18·13	18·68
	100	100	100

The means of the numbers yielded by the three experiments are given underneath in column (*a*). The numbers in column (*b.*) are the quotients of the corresponding ones in (*a.*) divided by the respective atomic weights of carbon, hydrogen, and oxygen, and those in column (*c.*) are others in the same ratio with the quotients.

	(*a.*)	(*b.*)	(*c.*)
Carbon	68·13	11·132	4·804
Hydrogen	13·33	13·330	5·753
Oxygen	18·54	2·317	1·00
	100·		

The inspection of the latter shows that the most probable formula for the oil is $C_5\ H_6\ O_1$, which would give the following parts per cent.

Carbon	68·60
Hydrogen	13·45
Oxygen	17·95
	100·

Assuming this formula as the true one, the deficiency in the carbon experimentally determined is not greater than what usually takes place; but the error in the hydrogen, though trifling in amount, being upon the opposite side to that on which it usually occurs, it became expedient to resort to some method of verification. The specific gravity of the vapor of the oil was therefore taken according to the well-known method of Dumas.

The weight of glass ball filled with dry air, the pressure being 30·324 and temperature 48°·5, was 914·86 grs.

The ball was sealed at 364°, and then weighed 917·78 grains. Hence 917·78—914·86=2·92 grains is the excess of the weight of vapor in ball over that of the air displaced.

The capillary end of the beak attached to the ball having been broken under mercury, it was ascertained by the amount of this metal which flowed into the ball, that its capacity was 16·76 cubic inches, which, at a pressure = 30, and a temperature = 60°, will (supposing it air) become

$$16·76 \times \frac{448+60}{448+48·5} \times \frac{30·324}{30} = 1·7333$$

cubic inches. From this must be subtracted ·1 cubic inch which was found to remain in the balloon, so that the bulk of air excluded by the vapor, when reduced to the mean temperature and pressure, was 17.233 cubic inches, whose weight = 5·344 grains. Hence 2·92 + 5.344 = 10·264 is in grains the weight of the vapor.

The capacity of the glass balloon at 48°·5 being 16·76 cubic inches, it will, owing to the expansion of glass, become at 364° 16·843 inches. This, therefore, is the volume of the vapor and bubble of air at 364°. But the volume of the latter being 0·1, it will at 364° become 0·16. Hence the true volume of the vapor at 364° = 16·843 — 0·16 = 16·683; so that

$$16·683 \times \frac{448+60}{448+364} \times \frac{30·324}{30} = 10·549$$

is the volume of the vapor reduced to a temperature = 60°

and pressure = 30. But as this weighs 10·264 grains, 100 cubic inches of it would weigh 97·298 grains. The specific gravity, therefore, of the vapor is $\frac{97 \cdot 298}{31 \cdot 0117} = 3 \cdot 137$.

Now if the composition of the oil be $C_5 H_6 O_1$, the specific gravity got by adding together the products of the densities of the vapors of the different elements by the number of atoms of each would be 3·072. But we have here so close a correspondence between experiment and calculation, that no doubt can remain as to the correctness of the basis on which the latter rests, or that the true formula for the oil is that already assigned.

These experiments were made in the winter of 1839, and at the time I had concluded them I was under the impression that the oil, to which they relate, was a new substance, or rather one which had not been previously described. In some time after, however, upon looking over the second part of Mr. Graham's Elements of Chemistry, which had been sent me by the author, I was much surprised at finding at page 134, in a table of the volumes of atoms in the gaseous state, mention made of a substance under the designation of "oil of the ardent spirit from potatoes," to which he attributed the very same formula and density of vapor which I had found to belong to the oil found in grain-whiskey, in the examination of which I had been recently engaged.

Anxious to investigate the matter further, and to ascertain if the two oils were certainly the same, I looked into Berzelius's System, and the 5th volume of the *Traite de Chimie, appliquee aux Arts*, by Dumas, devoted to the subject of organic chemistry, but could not find any mention in either of the essential oil from potatoe spirit alluded to by Graham. Upon, however, turning to Dr. Thomson's recent volume on vegetable chemistry, I found, page 481, a notice of this fluid, and references to the 30th and 56th volumes of the *Annales de Chim. et de Phys.*, in the former of which its origin and properties are described by Pelletier, and in the latter of which its analysis is detailed by M. Dumas. The properties I find ascribed by these chemists to the potatoe spirit of oil are precisely those which belong to that which I have examined from corn-whiskey, the only difference being that Pelletier represents its specific gravity as ·821, whereas I have found that of the oil I obtained from Mr. Scanlan but ·813, a difference, however, easily explained by the circumstance of his not having taken the necessary steps for rendering the fluid he examined perfectly free from water and alcohol. The analytic results also of M. Dumas are nearly identical with mine, approaching, however, more nearly, as might indeed be expected from his great skill in this department of chemistry, to the formula $C_5 H_6 O_1$ which he adopts, and which Professor Graham has taken from his memoir. I may lastly mention, as a very unusual coincidence, that the specific gravity of its vapor, as obtained by Dumas, is 3·147, or but unity in the second place of decimals greater than what has resulted for the corn-spirit oil from my experiments.

We thus arrive at the conclusion, that the two fluids are identical, or that the oil which has hitherto been considered as peculiar to potatoe spirit, occurs also in that which is developed during the fermentation of grain. From this latter source it admits of being procured in great quantity. When first observed by Mr. Coffey at Sir Felix Booth's, there was an inch of it in the faint receiver, and from the diameter of the vessel he estimated its total amount at 50 gallons. This is the quantity produced at that establishment every fortnight, the excise laws compelling the distiller to distil and brew alternately, and a week being generally consumed in each process.

The whiskey manufactured some years ago contained a considerable quantity of this oil, and owed to its presence a great deal of the pungency of taste by which it was distinguished.

From its high boiling point, and the nature of the stills at present used, but a very small portion of this substance now passes over, and hence the reason why the spirit at present made is, as compared with the product of the old processes, less disagreeable to the palate, and probably less injurious to the constitution. It is no doubt owing to the same cause, viz., an improvement in the process of distillation, that this oil has at length been noticed in the distillers' faints. Upon the old system of manufacture the greater portion of it was driven over, and was held dissolved by the spirit into which it was thus introduced; but with the modern stills, particularly that devised by Mr. Coffey, nothing having so high a boiling point as this oil can by possibility pass into the part of the apparatus where the spirit is condensed. With respect to the manner in which the substance originates, whether it exists ready-formed in the materials subjected to fermentation, or is a product of the process, I am not aware of any facts calculated to decide such a question. As, however, it is found in the fermented wash of both corn and potatoes, it may be presumed to be derived from the starchy principle which is common to both.

The potatoe spirit oil, as it has hitherto been called, has I find of late attracted much attention. Pelletier, from some rough experiments upon it with acids, threw out the conjecture that it was more analogous to alcohol than to the true volatile oils, and this opinion would seem to have been in some degree adopted by Dumas. More recently (*Ann. de Chimie et de Phys.*, Jan., 1839) M. Auguste Cahours has revived this opinion, and concluded it to be one of the group including alcohol, pyroxylic spirit, and acetone, and has even succeeded in procuring from it a carbo-hydrogen, in which the elements are, as usual, associated in the ratio of atom and atom. M. Cahours represents potatoe oil by the formula $C_{10}\,H_{11}\,O_1+HO$, which makes it as to composition perfectly analogous to ordinary alcohol. The carbo-hydrogen $C_{10}\,H_{10}$ he insulated by distilling the oil from anhydrous phosphoric acid. He calls it amylene, and finds the specific gravity of its vapor to be 4·904, so that an atom of it gives but one volume of vapor; a circumstance in which, as Cahours observes, it agrees with Dr. Kane's mesitylene, $C_6\,H_3$, but differs from the carbohydrogens which occur in alcohol and pyroxylic spirit. By acting on potatoe oil with sulphuric acid and chlorine, Cahours obtained compounds corresponding perfectly with those yielded by alcohol when similarly treated. These researches give additional interest to the discovery of this fluid in grain-fermented wash, and in such quantity as to be much more than adequate to meet any demand for it with a view to the interests of science.

I may here observe, that I should have long since presented this notice to the Academy, but for the following reasons.

There is another oily substance having, at common temperatures, the consistence of butter, which is long known to exist in the faints of grain spirit, and in smaller quantity in the spirit itself. Upon looking through systematic treatises on chemistry, I found that this oil had been very imperfectly described. and that, in particular, no experiments had been made with the view of determining its composition. I had therefore resolved to submit it to an accurate examination and analysis, and to keep back what I had ascertained in reference to the fluid oil until I had completed my investigations into the nature and constitution of that which is a soft solid at common temperatures. In this investigation I had made some progress, when my attention was directed to a paper by Liebig and Pelouze, in the 63rd volume of the *Ann. de Chim. et de Phys.*, in which, with their usual ability, they develope the nature of a butyraceous or fatty product which they had received from M. Deleschamps, and which comes over towards the close of the process of distilling wines with a view to the production of *eau de vie* or brandy. This oil they found to be a mixture of an acid which they called œnanthic acid, and of a compound of this acid with the oxide of æthyle, that is, of œnanthic acid and œnanthic æther. Upon perusing this paper I saw at once, from the experiments I had already made, that the fatty oil of grain and spirit was identical with this mixture, with the exception that some third oleaginous material was present, which Liebig and Pelouze had not found in what they had operated upon. Upon this third substance I have made some experiments, the results of which I shall probably at some future period submit to the Academy. I have resolved, however, no longer to defer giving publicity to my experiments identifying the fluid oils of grain and potatoe spirit, having had my attention drawn by Dr. Kane to a recent volume of Poggendorff's *Annalen*, containing a paper by M. Mulder, in which I find myself anticipated on the other point; and the butter of corn spirit is satisfactorily shown to be what I had concluded it to be, not entirely from my own experiments, but from a comparison of them with the researches of Pelouze and Liebig. Mulder also notices the third principle which is associated with the œnanthic acid and œnanthic æther, and describes it under the name of *oleum siticum*. The object, therefore, of the present communication is much more limited than it was originally intended to be, professing only to announce the detection of the potatoe-spirit oil of Pelletier and Dumas in fermented infusions of the mixed grains employed by the distiller. But as Mulder conceived his discovery of sufficient interest to justify him in giving it to the scientfiic world, I shall, I trust, be pardoned for bringing an analogous fact under the notice of the Academy.

The importance of the Ohio and Chesapeake Canal, as one of the great works of the Union, has induced us to devote more than usual space to the Report of Mr. Morris.

That portion which relates to the tunnel will be found highly interesting, as descriptive of one of the largest works of this character in the United States.

REPORT OF ELLWOOD MORRIS, CHIEF ENGINEER OF THE CHESAPEAKE AND OHIO CANAL.

CHESAPEAKE AND OHIO CANAL LINE,
December 31*st*, 1840.

To the President and Directors of the Chesapeake and Ohio Canal.

GENTLEMEN:—Pursuant to your order of December 15th, 1840, directing me to report,—1st. Generally upon the state of the work above dam No. 6.--2nd. Upon its probable aggregate cost, and the amount of work now done and to be done, &c. &c.

I have the honor to submit the following report, which, though somewhat more general, will be found to comprise the 1st head of your instructions.

And with a view to perspicuity, I propose to treat the subjects considered in three divisions:

1.—Entering succinctly into the history and design of the work, viewing it as a route connecting the Western waters with the sea.
2.—Treating of the canal now under construction from Cumberland, 50 miles down stream to dam No. 6.
3.—Noticing briefly the condition and prospects of the finished Canal, now navigated up stream from Georgetown to dam No. 6, a distance of 134 miles.

Work done during all 1840, *upon the* 50 *miles of unfinished Canal below Cumberland.*

WORK DONE.	From Jan. 1st, to May 1st, 1840.	From May 1st, to Dec. 31st, 1840.	In all 1840.
Upon the Sections, ...	$137,060 29	$304,166 67	$441,226 96
Upon the Masonry, . . .	22,288 13	67,645 54	89,933 67
Upon all the species of work,	159,348 42	371,812 21	531,160 63

By this statement, derived from the actual estimates made to contractors up to January 1st, 1841, it appears that work to the amount of $531,160 has been actually done in all 1840.

From information contained in the 12th annual report, we find that,

On the 1st of May, 1840, work done on the 50 miles of unfinished canal, amounted to	$2,242,945
To this add, work done from May 1st, 1840, up to January 1st, 1841,	371,812
And we have, total work actually done upon the 50 miles up to January 1st, 1841,	2,614,756

My predecessor, both in his revised estimate of December, 1838, and in that again revised of December, 1839, states the probable aggregate cost of the 50 miles of canal alluded to at $4,440,657

From which deduct work done January 1st, 1841,	2,614,757
And by that estimate, there will now be required to complete the canal an expenditure of	1,825,900

But my personal knowledge of the exact state of the unfinished line, together with the progress already made in the estimate I shall hereafter present, justifies me in the confident expectation that, by dispensing with some works not absolutely necessary—by building the remaining locks of rubble stone masonry (a mode not equal to that now adopted, but better suited to your financial condition)—by modifying the construction of some other works, and—by the probable reduced rates at which, with present prospects, the remaining work could now be let, an economical and judicious outlay upon the works, of a sum *not exceeding* $1,600,000 more, would enable you within 2 or 2½ years, to open the navigation of the canal from the Cumberland dam, throughout the 50 miles now unfinished, and thereby to complete the long anticipated continuous navigation from the county seat of Allegany, to tide-water within the District of Columbia.

1.—*On the General Design of the Chesapeake and Ohio Canal.*

The topography of the continent of North America, southward of the great chain of lakes, is remarkably simple in its general features; it consists of one magnificent valley—that of the Mississippi—of two mountain ranges—the Rocky Mountains, and the Alleganies—and of two sea slopes—the eastern draining into the Atlantic, and the western into the Pacific Ocean.

About three centuries ago, civilization first set foot upon the Atlantic Slope, and extending her domain gradually along the seaboard, it is scarcely a single century since the first settlements were planted beyond the Alleganies, in the eastern margin of the great valley referred to.

But within this short period, our enterprising countrymen have extended themselves so rapidly, as now to occupy the whole eastern slope of the Mississippi valley and a portion of the western. The great central valley having been mainly peopled by immigration from the Atlantic slope, and much of the foreign trade in articles of western consumption being still carried on through the Atlantic seaports, which afforded reciprocally a market for the products of western industry; it was very natural that our countrymen, both in the East and West, should early contemplate perfecting the communications between their old and new homes, even by subduing the obstacle, which nature had upreared in those numerous mountain ranges known as the Alleganies. Accordingly, we witness the great States of the seaboard, at immense expense, vieing with each other in establishing magnificent lines of transportation, to secure to themselves, as far as practicable, the traffic of that vast basin from which they are separated by the lofty crests of the Apalachian chain..

Stupendous are the barriers interposed by nature, but dazzling the stake they play for—costly must be the honorable strife, but splendid the reward accruing to that State which shall ultimately possess the most perfect line of western communication.

The trade with the great West naturally divides itself into two distinct branches—one light, demanding expedition, the other heavy, in which time is less an object; with extraordinary facilities for both, nature has singularly favored Maryland.

These advantages were early perceived and appreciated, by those valiant men who led the chivalry of the seaboard, in that ill-starred march, which terminated on the fatal field near Fort Duquesne, where Braddock fell a victim to his inexperience in woodland warfare.

There was one commander in that army whose quick eye was ever ready to note topography for future use—who had antecedently pursued his humble occupation of surveyor upon the margin of the Potomac, having been for some time foited upon the present farm of Mr. George Catlett, about 8 miles below your tunnel—and whose comprehensive mind quickly grasped the advantage offered by the valley of the Potomac as a western route, owing to that stream severing in succession every one of the numerous rocky ranges, known by the general name of the Allegany Mountains.

This officer—Washington himself—was the early and steadfast patron of improvements upon the line of the Potomac; and soon after the revolutionary peace, in fact on the 22nd of December, 1784, we find General Washington sitting as chairman of a joint commission of Maryland and Virginia, to take into consideration the propriety of improving the navigation of the Potomac to a point high up stream, and thence opening a road to join the western waters.

This commission recommended to the Legislatures of the two States the appropriation of a sum of money towards rendering the Potomac navigable to a point considerably west of Cumberland; thence to form a road cleared 80 feet wide to the Dunker bottom, on the Cheat river, and thence to form a batteau navigation to the Monongahela.

This action clearly indicates that Washington and his compatriots looked upon the improvement of the Potomac merely as forming a link *in a great route west.*

At that early period no one believed it practicable to surmount the Allegany by a continuous navigation; the demonstration of this momentous fact was reserved for those able officers of Engineers, who, under the direction of the U. S. Board of Internal Improvements, made in 1826, the preliminary surveys for the present Chesapeake and Ohio Canal, and who then established, in a most scientific and conclusive manner, that the Allegany summit of this work actually possesses a command of water ample to meet the exigencies of trade.

In 1784 the Potomac Co. was chartered by the commonwealths of Maryland and Virginia, who subsequently commenced operations under that charter, and effected an essential amelioration of the navigation of the river, especially at the Great and Little Falls; but their improvements being found in 40 years to fall far behind the wants of the country, they were superseded in 1824 by the charter of the present Chesapeake and Ohio Canal Company, to whom all the rights, interests, and privileges of the Potomac Company were ceded by a deed of surrender, dated the 16th of May, 1825.

The Chesapeake and Ohio Canal Company was organized in 1825, and on the 4th day of July, 1828, the first ground was broken upon the canal, by his Excellency John Quincy Adams, then Chief Magistrate of the Republic: since that day, with various fortune, this great work has struggled onward, deserted within a few years by all her early patrons, except the commonwealth of Maryland, in whose bosom alone she has of late been fostered.

Although this important enterprise is evidently destined for many years to be nothing more than the Georgetown and Cumberland—or at the most, the Baltimore and Cumberland canal—still as it was originally designed to connect the western waters with the sea, by an artificial navigation, and as the day will come when Maryland will find herself free from debt, and ready perhaps to reap the fruits of her geographical position, it may be as well to notice briefly the physical advantages which nature has lavished on this state, by laying through her bosom the only western route, possessing a summit sufficiently well watered to guarantee the maintenance of a continuous navigation across the mountains; which by its superior economy in the carriage of the heavy and slow trade, would inevitably enable its proprietor to disregard and overthrow the competition of all the rival lines in such a traffic.

Whoever studies a map of the United States, will perceive these facts—the Erie Canal turns the north eastern flank of the Apalachian chain, by an admirable water route; whilst Tennessee and Georgia with their improvements turning its flank in the south western quarter, have been compelled to resort to railroads; and of all the western lines of transport between these limits, surmounting the crests of the Allegany, none are practicable without a railway portage—save the Maryland route alone; with this line, but two can by any possibility enter into competition, and these are the Pennsylvania and Virginia routes, the relative advantages of which will be perceived by a comparison of the following tabular statements.

VIRGINIA ROUTE,

From tide water on the seaboard to steamboat navigation on the western waters.

TERMINI.	Character of Improvement.	Length in miles.	Height of the Allegany summit above tide in feet.	Total Ascent and Descent in feet	Miles of Canal.	Miles of Railroad.
Richmond to Covington,	Canal	239	1987	1229	239	
Covington to the Kanawha,	railr'd.	138		2137		138
Tide water at Richmond to steam navigation on Kanawha,	Mixed	377	1987	3366	239	138

The above is deduced from a work upon the "Laws of Trade," by C. Ellet, Jr. Esq., late Chief Engineer of this improvement.

PENNSYLVANIA ROUTE,

From tide water on the seaboard to steamboat navigation on the western waters.

TERMINI.	Character of Improvement.	Length in miles.	Height of the Allegany summit above tide in feet.	Total Ascent and Descent in feet.	Miles of Canal.	Miles of Railroad.
Philadelphia to Columbia,	Railroad	82		873		82
Columbia to Hollidaysburg,	Canal	172		748	172	
Hollidaysburg to Johnstown,	Railroad	36	2941	2570		36
Johnstown to Pittsburg,	Canal.	104		471	104	
Tide water at Philadelphia to steam navigation at Pittsburg,	Mixed	394	2491	4662	276	118

The above information has been deduced from the reports of the Canal Commissioners of Pennsylvania.

MARYLAND ROUTE,

From tide water on the seaboard to steamboat navigation on the western waters.

TERMINI.	Character of Improvement.	Length in miles.	Height of the Allegany summit above tide in feet.	Total Ascent and Descent in feet.	Miles of Canal.	Miles of Railroad.
Baltimore to Georgetown,	Canal	45		294	45	none
Georgetown to Pittsburg,	Canal	341	1903	3158	341	none
Tide water at Baltimore to steam navigation at Pittsburg,	Simple	386	1903	3452	386	none

The above has been deduced from the reports of General Bernard and Dr. Howard.

Although it would appear from the above tables, that the Virginia route possesses a slight advantage over that of Maryland, both in distance and rise and fall, if we consider Baltimore as the terminus, still the great length and ascent of its railroad would utterly prevent a profitable competition in heavy articles—and as to the Pennsylvania route, her 118 miles of railroad, her transhipments, and her small canals of 40 feet surface and 4 feet depth, combined with the great excess of lockage, will forever render it impracticable for that line to compete economically in the transportation of burden, with a continuous canal of 50 feet water line, and 5 feet depth—capable of bearing on its bosom boats freighted with 75 tons weight.

Indeed an able Civil Engineer and distinguished writer has lately urged as the only means by which Pennsylvania can render her works profitable, that she should construct a continuous canal across the mountains, even though it were necessary to pump by steam from the Conemagh the water requisite to feed it!

In commencing the Chesapeake and Ohio Canal upon its eastern section, it was a fatal mistake not to have begun at Cumberland, and proceeded towards the market, instead of from it; had this been done, the work with less than the present outlay would have been now finished to the "Point of Rocks," there connecting upon the one hand with the Baltimore and Ohio Railroad, and dropping into the river by temporary locks upon the other; the minerals of Allegany could have been poured at will either into the city of Baltimore or the District of Columbia; between which last and the "Point of Rocks" a very passable navigation existed formerly by the works of the Potomac company; finished to this point, the canal, without any material prejudice to the mining interest, and with vast benefit to the finances of the state, might have rested until its revenues supplied the means of further progress.

* * * * * * * * *

This tunnel is 3118 feet long, and its transverse section of excavation 27 feet wide by 25½ feet high, the sides being cut plumb, the top a semicircle, and a solid tow path of rock being left in; when completed, the arch will necessarily contract its dimensions, and it will then have a water way of 19 feet wide, and 7 feet maximum depth, a solid tow path of 5 feet clear width, guarded by a brick parapet, and the soffit of the arch at the crown will be 17 feet above the water line of the canal—thus offering a convenient and ample navigation for the transit of single boats or boats in a single line.

The excavation hewn throughout its course from the solid rock, has been carried on by means of two sets of working shafts, wrought by horse gins, the shafts being 183 and 122 feet deep respectively; and also by open drift from the south portal, where the excavated materials were carried out upon a railroad laid on the tunnel bottom, and thrown away as spoil bank in the river.

The excavation has been uniformly advanced by blasting in two breasts, first, the *heading*, being a cut of 12½ feet high next to the tunnel; and second, the *bottoming*, being a thorough cut of 13 feet deep, extending from the floor of the *heading* to bottom of canal, or rather to the bottom of the tunnel, which is one foot below.

Upon the 5th day of June, 1840, the *heading*, which by day and night (Sundays excepted) had been wrought, without intermission, since June, 1837, was completed and opened by effecting a junction between the working proceeding north from the southern portal, and that driving south from the deep working shafts: the other shaft workings having been finished in the year 1839.

This junction took place at a point 1503 feet inward from the south portal, and 340 feet deep, beneath the surface of the ground. Upon clearing the way for the instruments of the Engineer, it was found that all the lines and levels previously given in the several workings, under all the disadvantages caused by a transfer of levels down the shafts, by the smoke of powder and by the darkness, verified and coincided with extraordinary precision, whilst the meeting of the workings was exact.

Very little trouble has been experienced in ventilating the workings of this tunnel; no artificial means having ever been either needed or resorted to, except an occasional fire at the feet of the shafts, or in their man holes. The working shafts, having been sunk in pairs, 15 feet clear apart, and joined by suitable man holes, there was never any difficulty in producing a circulation of air by the aid of fire, or in directing the pneumatic current at will, either up or down a particular shaft. And so pure was the air in the *heading*, at 1500 feet from the south or open portal, where no air shaft or artificial ventilation was ever required, that I entertain not the least doubt that a tunnel of the dimensions of this one might be driven in such material, from an open portal, near half a mile under ground, without other ventilation than would be produced by the natural currents of air from the open end. The British miners, in their coal workings, regard 300 yards lineal as the maximum length to be given to drifts without air shafts; but experience here indicates that, in works of this size, penetrating a material which engenders no deleterious gas, 500 yards lineal may be driven with entire safety, and perhaps even far exceeded.

In November, 1839, when the two main workings had approximated within 600 feet of each other, and were respectively 325 and 310 feet deep under ground, the sound of the blasts in both workings was reciprocally heard in each, through the intervening mass of solid rock, resembling a dull tap with a hammer; and when they had attained a distance of 150 feet apart, the sound of the advancing hammers of the miners could be heard through.

The drainage of this tunnel has never been very great, not having, at any time, exceeded an average of *four* cubic feet of water per minute.

As but 1,502 feet lineal of the full section of *bottoming* now remains to be done, the tunnel excavation is in such a state of progress that, by pressing it vigorously, there would be no difficulty in bringing it alone to completion in 18 months; and inasmuch as the arching could and ought to be commenced before the excavation is all removed, (because the packing behind and over the arch is to be supplied by the spoil of the *bottoming*,) if the manufacture of brick, which has been too long delayed, was promptly commenced, the arch and tow path could be finished, and the tunnel thrown open to the navigation within 30 months.

It was long hoped that arching this work would either be dispensed with entirely, or at the most, that a short arch at the portals would be sufficient; but such is the character of the material, the absence of coherence between the strata, and so extensive the falls of rock from the roof, which are continually taking place, that, having carefully watched this work from its very inception, I have come to the decided conviction that a thorough arch is indispensable to the safe and uninterrupted transit of boats.

As it has been imagined by some that the arching would require a long time, it may be as well to give an outline of the plan upon which I have long contemplated proceeding with this portion of the work, and by the execution of which I have entire confidence that, with a heavy force, this formidable arch, though 3,118 feet long, and requiring about three and a half millions of bricks, can be constructed in a single year: the bricks being prepared beforehand and delivered at the portals.

By the experiment of Col. Pasley, of the Royal Engineers, of Mr. Brunel and others, the cohesive power of cement has been demonstrated to be so great, that from 20 to 30 bricks, with their longest dimension vertical, have been stuck out horizontally from a wall, by adding successively a brick at a time as soon as the cement joint of the preceding one had set.

Acting upon the principle of cohesiveness here developed, possessed, as it is in an eminent degree by the hydraulic cement of the Potomac, which I contemplate using in the arch at least, without any admixture of sand, in order to procure a quicker set and firmer bond, I propose,

1—With a srong force, to raise both side walls up to the springing line of the arch.

2—In sections of, say 5000 feet, by reverse moulds and without centering, to carry up the arch on both sides to the angle of repose, and bringing into play the coherence of the cement, even above it, say to an angle of 40 or even 45 degrees, as may be determined at the time.

3—By a system of detached centres, framed to leave open about 30 degrees of the crown, each supporting three feet lineal of the arch, and leaving an interval of four or more feet to be sustained by the cohesive power of the cement, to carry up the spandrels of the arch to an angle of 75 degrees or within 15 degrees of the crown on each side.

4—By a very light centre, (capable of being handled by two men,) to key up the crown in sections of 2 feet, shifting the centre crown continually, (upon a platform carried by the detached system,) as each successive section of the crown is keyed up and packed.

Those who are conversant with practical affairs, will at once perceive that, by working in long sections, course by course successively, the cement will set in one part whilst the workmen are engaged at another; and that by the division of labor indicated in the above outline, a very large force can be employed upon the arch, and so organized as to finish each part in detail; the most tedious portion, that of keying up, being limited, by the mode of operation, to 30 degrees of the crown alone, or but one-sixth of the semi-circle, can be advanced by working only from a single point, at the rate of 10 feet lineal per day.

(To be concluded in our next.)

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 8, Vol. VI. New Series. APRIL 15, 1841. Whole No. 380. Vol. XII.

It is a common remark, that those subjects which appear most familiar, are those upon which we have least accurate information. Railroads are striking illustrations of this, at least as far as the non-professional public are concerned. It is true that a few general notions are current, but these are rather poetical representations of what Railroads ought, or are to be, rather than correct delineations of the actual state of the system. To those who, from the duties of their profession, or from constant intercourse with well-informed persons, are familiar with the subject, it may appear that we have underrated the amount of popular intelligence in regard to Railroads—but an attentive examination will prove that our statement is correct. The daily papers, although in some instances affording praiseworthy exceptions, are generally far too inaccurate in their general notices, while a conversation with Railroad Directors themselves will often confirm us in the opinion that sound information is often most scarce where it is most needed. But the best evidence of the truth of our position is to be found in the avidity with which the most erroneous statements are copied and promulgated without any correction, and sometimes with the most fulsome praise of the "soundness of the views," the "happy generalizations," etc.

We have been led to these remarks by observing the effect of an article on the "Railroads of the United States," published some time since in "Hunt's Merchants' Magazine," a journal in general remarkable for the accuracy and usefulness of the information it contains. This article, upon which we intend making some comments, has been extensively noticed, without (as far as we have known) a single correction, and in two instances has been, in part, literally copied into the columns of daily papers as editorial, and in once case without even noticing the source whence it was taken. This was more remarkable, as the portion extracted contained the chief errors of the original.

The article in question contains a rather turgid, but tolerably correct, view of the capabilities and prospects of the Railroad system. The outline of the grand routes, either projected or executed, is correct in its statements, and decidedly good. But what we most seriously object to, and, unfortunately, the very portion which has attracted most notice, is a general view of the *great expense* and *unprofitableness* of Railroads. We give the passage entire. The Italics are our own.

"As regards the productiveness of Railroads, thus far, in the United States, to their stockholders, be they States or individuals, it is clear that as yet they have in general yielded but little profit, considering the amount of their cost. This cost is depending, of course, upon various local circumstances, such as the configuration of the territory through which they pass, the amount of excavation required, and the rocky or mellow nature of the soil. But even establishing the fact, which must be conceded by everybody, that railroads must occupy the place of ordinary roads, still the population of the country must grow much more dense; production, trade, commerce, and transportation, must be much augmented before they can all be very profitable sources of investment. *Their cost is generally great.* Besides the expense of making the ground nearly level wherever they pass, which is not required in ordinary roads, the construction of tunnels through solid rocks, and of throwing viaducts across rapid streams, a firm foundation must be made along the whole line of their tracks, either of wood or stone, wrought out at considerable cost. *These tracks must, moreover, be bound in a continuous line with thick bars of iron, cast in a peculiar form,* and up to this period, for the most part imported from abroad. To this may be added the expense of the engines, which is not generally less than several thousands of dollars; the passenger cars, which are constructed with great beauty, and enriched with the same adornments that are required in the most costly private saloon; the wages of experienced engineers, and their attendants; and the sum paid to individuals for the *user* of the land through which they pass, and for the wood which propels their engines. It must be evident that the cost of these tracks, running through long lines of distance, must in a short time be accumulated to a large sum, and a great amount of travel must be required, even to pay their expenses. *Yet it is well known, that only a few lines of railroads in the United States have yielded dividends to their stockholders.* It is to be hoped, however, that one important item will be saved by the non-importation of iron from abroad, as mountains of that mineral now slumber upon our land, inviting the pickaxe of the miner.

It would be unnecessary to point out to the professional reader the errors of this paragraph, did we not desire to embrace the opportunity of insisting upon the duty of Engineers to render the public a service, and advance the character of their own profession, by more frequent communications in our daily papers, and other journals intended for popular circulation.

It is well known, to Engineers, if not to financiers, that some of the best stocks now in the market are those of Railroads, which have never been down to par since their completion. The readers of the Railroad Journal have been so frequently presented with illustrations of this important fact, that they need not to be convinced of what is already so evident.

The next passage which we quote is a fair sample of the general style of the article.

"The next consideration which naturally comes before the mind in measuring the advantages of railroads, compared with other means of transportation, is their danger, contrasted with other roads. To be driven along through plains and valleys, sometimes within three inches of jaggy points of rock, at the rate of twenty-five miles an hour, (but more generally at the rate of fifteen miles,) often verging near the borders of deep rivers or steep ravines, by the power of strong engines, which, if they should run off their narrow track, would be as unmangeable as the steed of Mazeppa, and much more terrific in their struggles, is a matter, the danger of which is to be well weighed, before it is quietly submitted to; and in order to adjudge the risk, we only have to compare it with that of ordinary roads. The common roads, it is well known, cannot be travelled without the chances of accident, attended with injury. For example, the common road is often rough, and filled with obstacles; the carriage to which the horse is attached may break down or be upset; or the buckles and straps which confine him may give way and affright the animal; or the carriage, placed high upon its axle, may be overturned. On the other hand, the railroad cars, which in England ordinarily travel twenty-five miles an hour, and in this country sixteen miles, are, in the first place, perhaps, more dangerous from this very momentum. The boiler may explode, the car run off its track, or a mischievous boy may place an obstacle which will obstruct the passage of the cars, or remove one of the bars; the train may crash against the points of rock that constitute the walls of its tunnels, or rush off one of the steep embankments which border it. Yet the engines, boiling with ambition, and seemingly with rage, have no latent passions, like those of the frightened or maddened horse; the track is a level track, easily to be coursed by the naked eye, for a long distance, and the engines are usually provided with large shovels, which throw off from the path any obstacle which might oppose its progress. Besides, the engine at full speed can be stopped, at the distance of two hundred yards; and even were the cars demolished by concussion, the train behind would, if it kept upon the track, sustain only a temporary shock or delay. But we have accurate data of the actual amount of the loss of life by railroads in England, from well authenticated official reports, running down to November of 1838; and from these reports it appears that in that country there have been only ten passengers killed, out of forty-four millions transported."

It is much to be regretted that, in treating a subject which requires the plainest language and the strictest adherence to fact, so much poetical imagery should have been used. There is, and there has been, no greater enemy to the cause of internal improvement than the unbounded exaggeration which has characterized the language of those who, without knowing much of the matter, have ventured to say a great deal. No sensible man will give credence to that which appears to need such extravagant puffery; and the time has arrived when the discussion of Railroads and Internal Improvement must be rather mathematical than poetical.

Specification of a Patent granted to HENRY MONTAGUE GROVER, *of Boveney, Buckingham, for an intended method of retarding and stopping Railway Trains.* [Enrolled Nov. 2, 1840.]

The "method" here patented, if not an improved, is at least an abundantly "singular" one. From the lower frame of the carriage or truck, a wooden block or box is suspended by a bar link, within about half an inch, more or less, of the wheel; this box contains a large soft iron horse-shoe, enveloped for iron helices for converting into a powerful electro-magnet when its good offices are required. From these helices, wires proceed up into the carriage where a galvanic battery is situated, and with which they can be connected at pleasure. Should any accident or other circumstance render it expedient to retard or stop the train, connecting the wires with the battery, converts the horse-shoe into a powerful magnet, which, hanging within a "striking distance," catches hold of the rim of the iron wheel, pressing itself and the wooden box against it, after the manner of the brakes usually employed. The patentee states that these electro-magnetic brakes may be applied to one or more of the wheels of a train, or the apparatus may be applied to one wheel, and its action transmitted to other wheels by means of levers. We apprehend Mr. Green has greatly underrated the extent of power required to arrest the progress of railway trains, and the electro-magnetic power capable of being obtained by the means he proposes.—*Mech. Mag.*

Specification of a patent granted to WILLIAM PEIRCE, *of James's Place, Hoxton. for improvements in the construction of Locks and Keys.* [Enrolled Nov. 2, 1840.]

These locks, which are upon Barron's principle, with numerous tumblers, are furnished with a detector, consisting of a sliding bolt acted upon by any one or all of the tumblers; the opposite end of this sliding bolt is joinied to a small lever, mounted on a suitable axis. Within a tube, opposite the lower part of the key-hole, a dart, or sharp-edged punch is placed upon a strong spiral spring; there is a notch on the under side of the dart, in which the detector level rests, and holds the dart down upon the compressed spring. On attempting to open the lock with any but the original key, one or other of the tumblers is over lifted, which, acting on the detector level, releases the dart or punch which flies out through the keyhole, wounding the hand that holds the key. The face of the punch being in the form of a letter or figure, inflicts a wound that for several weeks identifies the aggressor; these locks have therefore been termed *Identifying Detector Locks.*

In order to prevent the accumulation of dirt, &c., within the pipe of the key, a metal stop is fitted so as to work freely within it, being kept flush with the end of the pipe by means of an internal spiral spring, which yields to the pin of the lock when in use.

The claim is,—1st. The mode of constructing detecting locks, 2nd. The mode of applying spring stops to keys.—*Mech. Mag.*

For an *Excavating Machine;* Joseph Hanchett, Coldwater, Branch Co., Michigan, February 28.

"The nature of this invention consists in combining together a common wagon, with a rising and falling frame containing a plough for loosening the earth, and turning the same into the buckets of a revolving vertical wheel placed behind the forward plough, and at the side of another plough; which elevates the earth and deposites it at the side of the excavation, or into a box or receiver on said wagon, or into a cart. Also in shaping the side of the ditch by trail cutters behind; the whole being drawn forward by animal power." The claim is to "the before described combination and arrangement of the elevating wheel, ploughs, adjustable frame, and inclined trail cutters, for excavating and cutting ditches."

This plan will, we are convinced, add another to the many abortive attempts which have been made to construct excavating machines for ditching and embanking, or for loading the excavated earth into carts, or other vehicles. We are aware that there are in operation some very useful machines for excavating, but we do not know of any completely successful effort to accomplish the purposes proposed by that before us. The object is one of great importance, particularly in the prairie regions, and there are several individuals now at work, seeking to obviate the objections to the machines heretofore essayed. We think that they are, in general, aiming at more than they will be able to effect, but doubt not that some valuable improvement will be made in this department of engineering.—*Jour. Frank. Inst.*

Metallic Relief Engraving.—1. Take a tablet of plaster of Paris, and, having heated it, apply wax for absorption to all the faces save that on which you intend your drawing to be, and to that one apply your drawing, executed with lithographic ink, on lithographic transfer paper. Let the side of the tablet on which is the transferred drawing be now dipped in weak acid and water, and then permitted to absorb a solution of sulphate of copper. By electro-metallurgy a deposition of copper can be made on all parts stained with the sulphate. Ere this coating be too thick, let the tablet be removed from the vessel in which this last operation has been carried on, washed *carefully*, dried, and a mixture of isinglass and gin be poured on it; its redundancy be gently blotted off with blotting paper till the surface be level (*i. e.*, the copper lines and isinglass cement be of the same height): again, let the deposition take place, and again its succeeding operation; after which let common black lead be rubbed over the whole surface; and the deposition being removed, a copper mould, from which a type metal block may be subsequently cast, is now formed.

2. Draw with a pen dipped in warm isinglass colored cement, and when your drawing be dry, for an instant expose it to steam, and then coat it with leaf gold. Proceed by electro-metallurgy, as in last method, and no cast is necessary.—*Atheneum.*

Artesian Wells in the Oasis of Thebes.—M. Ayme, a French chemical manufacturer, has been nominated by the Viceroy of Egypt civil and military governor of the whole of the Oasis. This Oasis is 23 leagues in length, and from two to four in breadth. That of Garbe, where there is also an alum manufacture, is about 20 leagues in extent. These two Oases contain, it is said, some excellent soil, calculated for raising indigo, cotton, sugar, and madder; they are studded with Artesian wells, which have been noticed by Arago. The ancient inhabitants used to dig square wells through the superficial vegetable soil, clay, marl, and marly clay, down to the limestone, from 20 to 25 metres in depth. The last rock contains the water which supplies the wells, and is called by the Arabs *Agar el moya.* In the rock, holes were bored from four to eight inches in diameter. These holes were fitted with a block of sandstone supplied with an iron ring, in order to stop the supply, when there was danger of inundating the country.

Wonderful Artesian Well.—At last, after *seven years* assiduous toil and boring, to the depth of 1700 feet! on the 26th February, *M. Mulot,* the engineer, who had persevered against all discouragements in the enterprise, was rewarded, at the moment of withdrawing the iron rod, (as thick as an ordinary axletree,) with a copious gush of warm water. At the sight of it he exclaimed, not unlike the Greeks under Xenophon, on reaching the sea, "Water! water!" and in his working clothes rushed to the Town Hall, where the municipality were in session, and bursting into their midst, repeated "Water! water!" and they in turn cried "Huzza for *Mulot!*"

The site of this remarkable well, which continued to pour forth a full and constant stream, was at the public slaughter-house, near the barrier of *Grenelle.* Mulot was honored with a decoration in consequence of his success. He is to be employed in piercing three other such wells.

Crowds of curious persons had continued to visit the wonder, all carrying away in vials and bottles portions of water, and some shaving themselves in public with the warm fluid. Ministers had also visited it. The water will, it is supposed, suffice for the supply of the neighborhood of Chaillot, of the Military School, and the Invalides. Warm baths for the accommodation of the people are to be constructed and supplied from this source.

Zincing Copper and Brass.—M. Boettiger has succeeded in covering plates and wires of copper, brass, pins, &c., with a brilliant coating of zinc. His method is as follows:—Granulated zinc is prepared by pouring the fused metal into a heated iron mortar, and stirring it rapidly with the pestle until it is solidified. The metal thus granulated is placed in a porcelain capsule, or in some other non-metallic vessel. A saturated solution of sal-ammoniac is poured over it; the mixture is boiled; the objects to be rendered white are now placed in it, previously dipped in dilute hydrochloric acid: in a few minutes they are covered with a brilliant coating of zinc, which it is very difficult to remove by friction. The galvanic action is thus explained:—The double chloride of zinc and ammonium formed is decomposed by the zinc and the plate of copper; the chlorine disengaged from the sal-ammoniac goes to the zinc; the ammonium is disengaged in the form of gas, and the undecomposed sal-ammoniac combines with the chloride of zinc to form the double chloride, a very soluble and easily decomposed salt. If, then, an excess of zinc exists in the solution in contact with the electro-negative copper, the salt is decomposed into its elements, and the reduced zinc is deposited on the negative copper.—*Athenæum.*

History of Steamboats.—The following facts, which are condensed by the Baltimore Sun from a lecture recently delivered before the Baltimore Mercantile Association, will prove interesting: "In England, although the use of labor saving machinery had begun to be entertained by many ingenious minds, yet its full development was at once stifled by the poor workmen, on the one hand, lest they should lose the means of obtaining bread for their families, and by the alarm which the rich entertained lest the poor thus deprived of employment should be thrown upon them for maintenance. But in America no such retarding motives were in operation. There was work for a hundred hands were there was but one pair of hands to perform it. And this necessity developed the genius of invention for which the people of this country have become so remarkable. The brief history given by the lecturer of various inventions originated or successfully applied in the United States, was highly interesting, and the description of the descent of the first steamboat on the Ohio and Mississippi rivers, during the earthquake of 1811, held the audience in almost breathless attention. The credit of having first applied vertical paddle wheels to the sides of a boat, and for having first constructed a boat upon this principle, Mr. Latrobe contended, should be shared with Mr. Rosevelt and Mr. Stevens; from the former of whom, he thinks, the principle now so successfully applided to steamboats was obtained by Chancellor Livingston and communicated to Mr. Fulton while Mr. Livingston was Minister to France. And had Mr. Fulton delayed but a few weeks his successful trial upon the Hudson, Mr. Stevens would have had all the honor which now attaches to Mr. Fulton, for he was also building a boat on the same principle, and finished it but a few weeks after Robert Fulton's experiment with his boat. The original idea of vertical paddle wheels applied to the centre of a boat is so curious that we will give it as mentioned by the lecturer. Mr. Rosevelt, of New York, the same who built the first steamboat on the western waters, and with his family descended the Ohio and Mississippi, during the fearful earthquake of 1811, while a boy, amusing himself with making and launching tiny vessels, cut out of a shingle the rude form of a boat; across the centre of this he laid a small shaft, which projected over the side of his boat, he attached wheels with four arms, similar to the wind mills which the boys are in the habit of making. Around the shaft he wrapped a piece of twine, and then to the end of the twine attached a bent hickory spring. He then placed his little vessel in the stream, and had the delight to see, that as the spring moved and drew upon the thread and unwound it, the wheels were set in motion and the boat moved forward upon the water. This was some twenty years before Fulton's successful trial upon the Hudson. After this, and before Mr. Fulton was known in this matter, Chancellor Livingston, Mr. Rosevelt, and Mr. Stevens, of Hoboken, were jointly engaged in the endeavor successfully to apply steam to the propelling of boats. The lecturer said that he had in his possession the correspondence which passed between these individuals at the time their experiments were in progress. Mr. Rosevelt wished to apply the wheels vertically, and at the sides; but the Chancellor's idea was that the true principle was in the horizontal wheel, applied to the stern. The latter overruled, and thus the boat was constructed, and put in motion in the bay of New York. It proved to be a failure, as its speed was only about three miles per hour. The partnership was then abandoned; when Mr. Rosevelt applied his principle to the same boat, and found it to work admirably. But the boat was too weak to bear the central application of power, and was racked so as to be unfit for use. Mr. R. then abandoned the prosecution of the matter for other and more pressing concerns. About this time Mr. Livingston was sent as Minister to France, and there met with Mr. Fulton. Encouraged by Mr. Livingston, the latter made many experiments upon the Seine, not however, with the power applied according to Mr. Rosevelt's idea; but in all he was successful. He finally, in New York, turned his attention to the vertical paddle wheel, centrally applied, and succeeded."

FRANKLIN RAILROAD.—The Hagerstown Torchlight states that the section of the above road between the Pennsylvania State Line and Hagerstown is completed, and the cars commenced runnig upon it on Wednesday. The occasion was duly celebrated by the citizens of Chambersburg and Hagerstown.—*Baltimore American.*

QUICKER YET.—The new Locomotive, "Owasco," with one passenger car went from Auburn to Syracuse on Thursday last, distance 26 miles, in 52 minutes. This is the quickest trip ever made on the road. The engine was built by Messrs. Dennis, Thomas and Wood of this place, and is superior as a piece of perfect mechanism to any thing we ever have seen.—*Cayuga Tocsin.*

[From the American Repertory.]

ERICKSSON'S PROPELLER.

Steamship Clarion, off Sandy Hook, April 14, 1841.

Capt. J. ERRICSSON—

Dear Sir:—The following memoranda of time and distance I send you by the pilot, who is now about to leave us.

	h.	m.
Left the Pier No. 1, North River, with a fresh breeze from the S.W., at	2	0
Passed Quarantine, Staten Island, at	3	0
Fort Richmond, a strong flood tide against us all the time, .	3	20
Passed ship Louisiana bound out, under all sail, at . .	3	30
Engine making from 41 to 42 revolutions per minute, and working as smooth as oil. I feel no more jar or annoyance while writing this than you would feel in your room at the Astor.		
Passed buoy off the Upper Middle, at	4	20
Passed beacon on Romer, bearing E.N.E., distance 1-4 mile,	4	30
Sandy Hook light house bearing W., distance 2 miles, and the pilot takes his leave of us, ...	5	00

We have not loosed a sail yet, and have had a fine chance to stow our anchors, &c., and get all ready for sea. I have not time to say more. Yours, &c.,

E. DUNN,
Comm'r Steamship Clarion.

Capt. J. ERRICSSON—

Sir:—As it may be interesting to you to learn the success of the steamer Clarion while under my charge, I subjoin the following particulars:

We left Pier No. 1, North River, at 2h. 3m. P. M., and I left the ship at 4h. 50m., Sandy Hook light bearing west 2 miles. Distance sailed, 21 miles in 2 hours 47 minutes, without canvass, against a head wind and tide, with occasional snow squalls.

Very respectfully, your obedient servant,

JOHN TURNURE, *Pilot.*

New York, April 15, 1841.

The report of the following experiments having been alluded to in our Journal, and the testimony of one party having been given, we proceed to publish all the details, and in a future No. an examination of the subject may be expected.

[From the Journal of the Franklin Institute.]

NOTES OF AN EXPERIMENT WITH LOCOMOTIVE ENGINES. BY GEORGE W. WAISTLER, ESQ., CIV. ENG. W. R. R.

It is the custom to speak and write of locomotive engines in reference to their power almost exclusively; hence we frequently see in the public prints notice of the performances of engines where the extraordinary results (if they be extraordinary) are set forth to show the superior power of the engine, and accompanied too with remarks calculated, if not intended, to lead the reader to believe that the builder, by some invention or peculiar mode of construction of his own, had succeeded in producing a greater effect from the same cause than had heretofore been accomplished.

That one engine may be of superior power to another of course is true; just as true as that one house may be of greater capacity than another, and for the same reason; because it is built to order on a large plan; but it must be equally true that an engine can have no greater power than is *due to the capacity of its boiler to generate steam,* and that the effect produced by this power can be no greater than is *due to the available weight of the engine for adhesion.* Yet it is sometimes stated that the engines of one maker with less available weight (weight on the driving wheels) than those of any other maker, have superior power and will draw much heavier loads.

To those at all acquainted with the present state of the locomotive engines, and the mode of construction pursued by almost all makers, both in this country and in Europe, to whom the causes for effect are obviously of so definite a nature, and so perfectly limited in every case—being subject to order—such statements and assertions seem strange and unaccountable; it is in fact to say that one pound used as a power will produce a greater effect than another pound, or more distinctly, that the gravity of one pound is greater than the gravity of another pound; and it must be attributed to the apparent inutility of contradicting such absurdities that these statements have been permitted to pass unnoticed. But since it is so apparent that few, if any, will take the trouble to investigate and understand the causes and effects in this machine, but rather treat all questions relating to it as matters of veracity, apparently regardless of the absence of all probability or even possibility of such effects from such causes, I am induced to offer the result of a recent trial on this road of two engines of different makers to ascertain their relative *effective* power.

I am the more induced to this, because I conceive the growing faith in these oft repeated and undenied statements of superior and *peculiar* power, is not only injurious to the builders themselves, but to the true interests of railroad companies.

It is of serious injury to railroad companies, because it induces them, in the expectation of rapid improvements, to limit themselves too closely in their first outfit, and then in the expectation of procuring something of superior and peculiar power, they are induced to go from maker to maker as each may set forth such claims; thus collecting a variety of pattern destructive of that uniformity in the several parts of the engine, which by affording the facility of shifting parts from one to another, or applying parts common to all, is so essential to the economy and despatch of the operations of the road. This variety of pattern and make on any road creates an equal variety of opinion and prejudice among the agents of the road, for and against engines of different makers, equally prejudicial to the maker and the company; when in fact there may not, and among makers of reputation (so far as power is concerned) there is not any other difference than may be the result of the architectural fancy of the builder, sufficient, however, to destroy all uniformity; and I am fully of opinion that this uniformity is of such importance, that all deviations should be avoided until the advantages of a change are of such an obvious nature as to render a total change desirable.

I presume the advantages of this uniformity in the parts of engines cannot be doubted. I have no hesitation in saying (and my experience leads me to it) that a given number of engines with perfect uniformity of parts, permitting the immediate shifting of parts from one to another, will perform more, much more work than the same number equally good in themselves, but all differing from each other, and that there are great advantages, t oo, in having all the engines on one road of the same make, I think, will be admitted, when, wherever this is found to be the case on any road; there you find the engines in the best order, and enjoying the best reputation; and whether this be the effect of the prejudices of those who use them, or their faith and natural pride in the good qualities of *their engines* where all are alike, instead of the variety of opinion, and equally natural prejudice in favor or against engines of particular makers where all are different; the public is there less incommoded, and the company less prejudiced by the delays consequent upon accidents to, or defects in the engines.

Another injurious effect upon railroad companies, and likely to be more serious in its consequences is, that this faith in the superior and *peculiar* power of engines, leads to expectations of almost unlimited effects; at least to such extent that almost any grade could be ascended without the least inconvenience: in short, expectations that could never be realized without some special dispensation of the law of gravity; yet in conformity with these expectations, it is frequently urged that roads should be constructed (with reference to cheapness) to conform nearly to the natural surface of the ground, regardless of steep grades, since engines had been *invented*, or certainly soon would be, with power to ascend the steepest as easily as they had heretofore on a level—and engineers are not unfrequently placed in the embarrassing predicament to be overwhelmed with *facts and statements !* in relation to the superior and mysterious effects of engines, depriving them of the immutability of nature's law of gravity to found an argument on.

The locomotive is a steam engine of the most simple form, and the general plan of construction pursued by almost all makers is essentially (so far as power is concerned) the same. The boilers, the source of power in all, are similar,* being cylindrical, horizontal and tubular; the only difference being that some have square or rectangular furnaces, and others have circular or rounded furnaces; each, however, being able to generate steam sufficient to overcome the adhesion due to the weight of the engine; indeed, this is understood by all good makers to be a necessary condition, and all that I am acquainted with accomplish it.

The reciprocating motion of the piston is applied directly by means of slides, and a connecting rod to produce a circular motion of the wheels, either by a crank in the wheel axle, or (which is the same) to a pin in the spoke of the wheel; the effect is precisely the same in both, and if the adhesion between the wheel and the rail be greater than the resistance to progressive motion of the engine and train (from friction and gravity) then will the whole advance; but if it be not, and there be steam power sufficient to overcome what adhesion there may be (and all engines have this power) then will the engine and train remain stationary, while the wheels turn round, slipping on the rails; and no additional application of steam power can cause it to advance; to say otherwise would be to say, that if I (*having strength sufficient*) should break a lever in attempting to lift a weight, another, *because he has greater strength*, could lift the weight with the same lever!

Yet this is what the public are made in a great measure to believe by the statements we so frequently see of the extraordinary performances of engines. It must be clear then, that the limit to the power of any locomotive engine to propel trains *is the adhesion of its driving wheels to the rails*, which adhesion is at all times, and under all circumstances, *in proportion to the weight on the driving wheels;* and although this adhesion is not the same (in amount) under all circumstances, varying as it is well known, with the condition of the rails, as effected by the state of the weather, &c.; yet it is *always the same with all engines under the same circumstances;* hence the relative effective power of any two engines—power to propel trains—must be strictly *in proportion to the whole weight on the respective driving wheels of each;* which will be seen to correspond with the result of the trial.

I give you the statement as made at the time, officially, to the

* This is not strictly correct, vertical tubular boilers are used on engines in Maryland to a considerable extent, and various forms have been adopted in England for the boilers of locomotives on both common, and railroads. Com. Pub.

President of the Corporation, for the information of the Board of Directors.

ENGINEERS' OFFICE, WESTERN RAILROAD,
Springfield, August 24th, 1840.

THOMAS B. WALES, ESQ., President W. R. R. Corporation.

DEAR SIR:—In accordance with the leave granted to Mr. Richard Imliy, by vote of the Board of Directors of the 11th of April last, to place an engine on this road for trial, he arrived at our depot here on Thursday afternoon, with a locomotive engine, constructed by Mr. William Norris, of Philadelphia; the engine is of the largest class; on eight wheels, four being drivers of four feet diameter; her cylinders are twelve and a half inches diameter, and length of stroke twenty inches.

It was arranged that the trial should be made next moring with this engine, to ascertain what load she could draw up the plane on this road, next to our depot here; (it being the maximum grade east of the Connecticut river) and also to see if one of the corporation engines could draw up the same plane an equal load in proportion to the weight on its drivers.

The foot of this plane intersects the level through the depot yard about two hundred feet from the passenger house, and rising at the rate of 60 feet per mile for 8,200 feet, then at the rate of 66 feet per mile for 2000 feet, then at the rate of 46 feet per mile for 700 feet, and thence to the top, at the rate of 60 feet per mile, is two and forty-four hundredths miles in length.

The engines being ready with full tenders of wood and water, and steam up, were brought to the platform scales to be weighed: the object being not only to ascertain the whole weight of each engine, but what portion of the whole weight is brought to bear on the driving wheels of each; it is known too, that when the steam is applied to give motion to the engine, the effect is to alter the distribution of the weight of the engine between the forward and driving wheels, relieving the former of a portion of their weight and placing it on the latter. Measures were taken in the weighing to ascertain the extent of this change; this was done by placing each engine, first, with the forward wheels on the platform scales; the tender, being attached to the engine, was chained to the track to prevent the advance of the engine when the steam was let upon the piston, that the effect might be exhibited by the scales; this effect was to relieve the forward wheels of a part of their weight.

The driving wheels were next placed on the platform, the tender chained to the track as before, and the steam applied; the effect was to increase the weight on the driving wheels.

The results of the weighing are as follows:—

Engine "America," built by Norris.

Weight on driving wheels,	17,550 lbs.
Do. forward wheels,	11,590
Total weight of engine,	29,140 lbs.

Weight of Tender, (eight wheeled) wood and water.

Weight on forward truck,	13,050 lbs.
Do. hind truck,	12,870
Total weight of tender,	25,920 lbs.

Weighing under Pressure of Steam.

Weight on forward wheels without steam,	11,590 lbs.
Do. do. do. with steam,	9,650
Difference,	1,940
Weight on driving wheels without steam,	18,620
Do. do. do. with steam,	20,010
Difference,	1,390

After this engine had performed her trip, she was placed again on the platform scales, it having been observed that she worked under higher pressure of steam up the plane than when on the platform at the first weighing; at this weighing the result was as follows :—

Weight on the driving wheels without steam,	19,220
Do. do. do. do. with steam,	21,070
Difference,	1,850

It will be seen that these several weighings differ in their results; this may be attributed, in part, (in the cases where the weights of the same parts of the engine differ when weighed *without* the action of steam) to a different state of the water in the boiler, and to the fact that at the first weighing of the driving wheels, the engineer and fireman were both off the foot board; but I am inclined to believe from the very great difference between the first and last weighing, which last was made with great care, that there must have been some error in reading off the first weight.

The difference in the weights under the pressure of steam may be attributed to the different positions of the cranks at the time of weighing, since the effect would vary from a maximum to nothing, depending upon their position.

Taking the weights, however, as they were recorded.

The first weight of the drivers without steam was	17,550 lbs.
Add weight taken from forward wheels by first weighing with steam,	1,940
Total weight on drivers in operation by first weighing	19,490
Second Weighing.—On drivers with steam,	20,010
Third Weighing.—On drivers with steam,	21,070
	3)60,570
Mean weight on drivers in operation	20,190

Engine "Suffolk," built at Lowell.

Weight on drivers,	16,150 lbs.
Do. on forward wheels,	7,480
Total weight of engine,	23,630
Tender (four wheeled) wood and water,	14,000

Weighing under Pressure of Steam.

Weight on drivers without steam,	16,075 lbs.
Do. do. with steam,	17,150
Difference,	1,075
Weight on forward wheels without steam,	7,480
Do. do. do. with steam,	5,700
Difference,	1,780

First Weighing.

Weight on drivers without steam,	16,150 lbs.
And weight taken from forward wheels,	1,780
Total weight on drivers in operation, first weighing,	17,930

Second Weighing.

Weight on drivers without steam,	17,150
	2)35,080
Mean weight on drivers in operation,	17,540

The effective weight (weight on the drivers) of the "America," Norris' engine, is	20,190 lbs.
That of the "Suffolk," Lowell, is	17,540

Immediately after the weighing was completed, the "America" was attached to a train, consisting of twenty-seven cars, and started on the level at the foot of the plane within about 400 feet of the plane, commenced ascending with a velocity of about seven miles per hour; ascended about one mile, gradually diminishing the velocity until the adhesion of the drivers being overcome, the wheels slipped, and the train stopped, not being able to proceed further up the plane with the load; returned with the train down the plane to the starting station. Mr. Imly was requested to take such load as he thought the engine would take up the plane at a speed not less than six miles per hour; he detached six cars; started again with twenty-one cars, gross weight, 259,698 lbs.; with this load she ascended the plane, with steadiness to the top in twenty-six minutes, being at the rate of 5.63 miles per hour.

The engine returned again, with this load, to the starting place, when the "Suffolk" (Lowell) was attached to the same train, leaving off four cars, taking seventeen cars, gross weight, 198,042 lbs.; with this load she ascended the plane to the top in 14¾ minutes, being at the rate of 9.92 miles per hour.

It was supposed when this trial was made, that the train would give a load to this engine equal to that taken by the "America," in proportion to their effective weights; but it was found, after weighing the cars, that the load was deficient.

The "Suffolk" was again attached to the train, with nineteen cars; gross weight, 234,218 lbs.; with this load she ascended the plane to its top in 21½ minutes, being at the rate of 6.8 miles per hour.

The whole load of the "America's" train, Tender included, was

Tender,	25,920 lbs.
21 cars,	259,698
Total,	285,618

That of the "Suffolk's" train, Tender included, was

Tender,	14,000
19 cars,	234,218
Total,	248,218

Effective weight of the "America,"	20,190
Do. do. do. "Suffolk,"	17,540

Then $\frac{17,540 \times 885,612}{2,190}$ = 248,129 lbs., the load the "Suffolk" should have taken; she did take 248,218 lbs., thus showing that the effect produced by each engine, except in speed, was as it should be, *equal.*

The greater speed of the "Suffolk" is most probably due to the greator diameter of her driving wheels: as the velocity of both trains was such—being small—the difference between them may not have materially effected the resistance.

The engine "Suffolk" is on four wheels, two of which are drivers, four and a half feet diameter. Cylinder twelve inches in diameter, and eighteen inches stroke. Pressure of steam in the boiler, ninety pounds. Pressure of steam in the boiler of the "America," one hundred and thirty pounds.

REPORT OF THE TRIAL OF THE ENGINE AMERICA, FROM BOSTON TO SPRINGFIELD, WEDNESDAY, 19TH AUGUST, 1840.

The undersigned a miniority of the committee appointed to attend the trial of an engine, made by William Norris, Esq., of Philadelphia, and who were also charged with a communication, from George W. Whistler, Esq., respecting the engines and cars required for the railroad west of the Connecticut, respectfully report,—

That on Wednesday, the 19th of August last, an engine made by Mr. Norris, called the "AMERICA," accompanied by an eight wheel tender arrived in Boston, and was attached to a train of thirty seven freight cars taken indiscriminately from those in use, in the Western and Worcester Railroads.

The "Engine" was a beautiful piece of workmanship, encircled by an iron frame, mounted on eight wheels, with straight axles, outside connections and superior in size to any in use upon the Western Railroad, and her whole appearance was highly creditable to the manufacturer.

The weather was fair, with but little wind, and all the circumstances as favorable to the movement of a heavy load as could be desired.

After some delay occasioned by the detention of some downward trains, the "America" was set in motion, at 53 minutes past 12 M., with the following load attached to her, viz. Tender with wood and water, as weighed at

Springfield, - - - - -	25,920 lbs.
37 Freight Cars, - - - - -	154,468 "
Merchandize, viz. Plaister, - - - -	235,200 "
80 Bales of Cotton, - - - - -	32,464 "
235 Casks of Spikes, - - - - -	34,125 "
	482,177

or 241 tons 177 lbs.

The net load of merchandize inclusive of the passengers on the engine a little exceeding 151 tons, with this load, the "America," made a very handsome sart from Boston, she passed the first ascending grade of 23 feet to the mile, 1900 feet in extent, at a speed of 1200 feet per minute, and the next grade of 13 feet to the mile extent, 5,850 feet at a speed of 600 per minute, and a grade of 29¾ feet, 3,800 feet long, at the rate of 576 feet per minute. After passing several feet of level road and light grades at a speed varying from 1050 to 1344 feet per minute, the train entered upon a grade of 30 feet to the mile extending 13,340 feet at a speed of 1300 per minute and proceeded about one mile upon the straight portion of this grade, gradually reducing speed, to 408 feet per minute, until entering upon a curve of 12 feet radius, the wheels began to slip, and it became necessary to increase the adhesion by the use of sand upon the rail; by the adhesive power thus gained, the "America" surmounted the elavation without stopping, and after considerable detention by various ascending and descending trains, reached Westborough in three hours, and two minutes running time, from Boston, being an average speed of about 10 miles per hour.

Upon entering the new track of the Worcester Railroad at Natick, a passenger car, estimated to weigh 12,000 lbs., and containing about 28 passengers, computed to weigh about 4000 lbs., was attached to the "America," and with the residue of the load, was drawn by her into Worcester, where she arrived with the train at a late hour of night, her power for the last few miles being severely tasked by this addition to the load and a copious dew, which moistened the rails. Although she actually carried this heavy load into Worcester, without aid from any other engine, the undersigned is satisfied that she could not have passed the curve, on the high grades, without the use of sand to increase the adhesion, and that the load was heavier than she could draw over the road against an adverse wind, or in an unfavorable state of the rails, or with a proper degree of speed. In suggesting this, however, he would not disparage the performance of the engine, as it far exceeds anything which has yet been accomplished on the Boston, and Worcester Railroad, 90 tons net weight of merchandize, being the heaviest load yet carried from Boston to Worcester, even with the aid of sand, on any trial of power, and by the annexed statement, marked A, furnished by Major Whistler, it will appear that the Engine "Suffolk," when tried upon the same road, with a view to test her power, carried but 86 tons of goods or about 56 per cent, of the amount moved by the "America,"—And it is also proper to remark, that the freight cars were not in perfect order, several of the wheels, causing an excess of friction by coming in contact with the sides of the cars, and the line of the draft being rather too high for the engine, while the Worcester Road is considered out of line; and there was reason to believe that if the road had been in good order, the "America" could have carried the same load with greater speed, and without the aid of sand, in a train of eight wheel cars, of approved modern construction.

The weather continuing fine, Mr. Imlay, the agent of Mr. Norris, concluded to try the engine on the Western Railroad, with the same train of freight cars and lading she had drawn from Boston, and a single passenger car.

With these she ascended the grade of 42 feet at New Worcester, but stopped at or near the summit, the load being too heavy. At this point the agent detached 5 freight cars, laden with plaister weighing together 58,483 lbs., and a passenger car, leaving the load attached to the "America" 423,624 lbs., of which rather more than 130 tons was merchandise. With this she started upon the grade, and proceeded to Charlton, passing over the summit level, which is the highest point between Boston and Springfield, in a very handsome style. Her time from Clapville to Charlton, 4½ miles, as taken with great care by the undersigned, was 39 minutes over an ascending grade, the entire distance, no part of which, as he is informed, was less than 30 feet, and 2½ miles of which was 48 feet to the mile. Her average speed, from Clappville to Charlton, was 6¾ miles per hour, and her lowest rate, near the summit, was about 4½ miles per hour.

Although this performance fell short of the sanguine expectation of Mr. Norris, it was highly creditable to the Engine, and very satisfactory to the miniority of your committee. It demonstrates to his entire satisfaction, that such an engine will carry with ease, from Boston to Springfield, a load exceeding 100 tons of merchandise, as an ordinary daily duty. And he was the more gratified with the performance of the America in passing the Charlton summit, with more than 130 net tons of merchandise, when he recurs to the fact, that our engineer, no longer since than March last, reported to the committee of investigation of the stockholders of this company, that the engines now in use on the Western Road, were competent to draw 59 tons between Boston and Springfield, and have, as he is informed in no instance drawn over 70 tons over the road. And he is satisfied, that we may now assume, as a basis, for estimating the cost of transportation, between Boston and Springfield, that at least 100 tons may be drawn in a train. After passing the high grades, on the Western Railroad, your committee considered their duties performed, and separated, after delegating to Mr. Jackson the office of attending to the weight of the engine, who proceeding to Springfield, and ascertained her weight to be 29,140 lbs., the weight upon her four drivers, when at rest. to be 18,620 lbs.

On the day after the arrival of the "America" and her train at Springfield, and in the absence of all the Committee, except Mr. Jackson, it was proposed to try her on the 66 feet grade, at Springfield, and with one of the Lowell Engines, the "Suffolk." This trial was made, and the result, is given in the annexed report of the Engineer, by which it appears, that the America carried up the plane, including 21 cars and tender, "a load of 285,618 lbs." in 26 minutes, and the "Suffolk" a load of 248,218 lbs. in 21½ minutes, by which it would appear that the "Suffolk" performed as much in proportion to the weight on the drivers as the America, and in less time.

The latter is also reported to have worked with a pressure of 130 lbs. to the inch, while the Suffolk worked with a pressure of 90. If this experiment, tried in the absence of a majority of the Committee, be a test of their comparative power, it would appear that the America possessed no decided advantage over the Suffolk with respect to power; but the miniority of your committee is not prepared to decide upon a single experiment, which may be, and often is fallacious, where comparisons are instituted and a predilection for one or the other engine may influence the judgment; and he places less reliance on this experiment, inasmuch as the Suffolk performed far more than she had done in her former trials while the America performed less; the load carried by her over the Charlton Summit the day previous being, by a computation made by the miniority of the Committee, equivalent to a load of 340,000 lbs. on the Springfield Plane, over which she carried 285,618 lbs.

The miniority of your committee cannot acquiesce in the results or recommendations of Mr. Jackson appended to the report of the majority, considering it altogether unjust to assume as a basis, for the calculation made by him, the weight upon the drivers of the America, after her descent from the Plane, and the weight upon the drivers of the Suffolk, before her ascent. Strict justice required that they should be weighed under the same circumstances.

Neither can he concede that the weight upon the drivers is the sole measure of the power of a locomotive, having satisfied himself that though an important element in furnishing power, its efficacy is materially increased or diminished by the steam power of the engine, the arrangement, and construction of the mechanism, the proportion and adaptation of the parts of the machine, the line of draft, and the mode of applying the power.

With respect to the America, it was apparent that she moved with great ease, both to herself and the road, that her motion being more equal, was less injurious than that of all four wheel engines, both to herself and the rail, while she is less liable to fly the track.

The undersigned has also been informed by the directors of numerous railroads, that the construction of the Norris Engine is far less complicated than that of the Lowell Engine, and that, of course, they are far less liable to expensive repairs, and when injured, are more easily repaired. And it is important to remark that the repairs of our locomotives consume a large portion of the profits of our railroads. And he would consider it altogether impolitic upon a road which must require a large number of engines, to order more until a thorough investigation has been made into their comparative merits. To determine with accuracy the relative powers of the "Lowell" and "Norris" Engines, further trials must be requisite.

And these trials and further inquiries are also requisite, to show their comparative consumption of fuel and other qualities, among which the minority of your committee consider a liability to expensive repairs or freedom from such liability, most material. And he is led to dwell more particularly on this subject, because he is informed that the average expense of keeping the Lowell Engines in repair, on the Eastern Railroad, is at least $15,00 per annnm, while Mr. Norris will guarantee his for $500 each per year.

He would, therefore, recommend the trial of farther experiments, and would particularly recommend that a load of 100 tons of merchandise in 30 cars be provided at Worcester, and the same be drawn from Worcester to Charlton on the same day by the Suffolk and America, and that an accurate account be kept of the time and fuel consumed by each; and before leaving this subject, he would remark that it would be doing injustice to the Suffolk, did he not say that her performance on the Springfield Plane was highly creditable to her, and indicates that she may possibly draw a much larger load over the Charlton summit than was originally anticipated. With respect to the other subject confided to your committee, the report of Major Whistler respecting the engine and cars required for the route west of the Connecticut, he would unite with the majority in reporting, that it is expedient to order four eight-wheel passenger cars, as recommended by Major Whistler, and would farther recommend that two of these cars be provided with water closets, and saloon for ladies, and that all be furnished with the vibrating plates in use on the railroads in the Middle States.

With respect to the freight cars, the minority of your Committee has made diligent inquiry, and has ascertained that the four wheel freight car is now gradually going out of use, and it is generally regarded in Pennsylvania, Maryland, and the Southern States, as much inferior to the eight wheel freight car.

The principal objections made upon our road to the eight wheel freight cars, are two. First, that they may be too large for the amount forwarded to the way depots. Second, that they require more labor to move them at the different stations.

With respect to the first objection, he would remark, that we already have at least single freight cars, which seems to be a liberal provision for the side depots, where little business is transacted, while the business at these depots, is increasing, and must continue to increase.

With respect to the second objection, he believes that it arises from the clumsy and defective construction of the few double cars in use in this section of the country, which has disaffected the operatives at the depots, and if these objections could not be easily obviated, the double cars are reported to have such decided advantages, that they are entitled to a preference. A good car of this description will carry from 10 to 12 tons of merchandise, with less jar and injury to the freight than a single one; is more convenient for stowage; will conform to the curves of the road, diminish the length of the trains, and the resistance of the wind, and do least injury to the track, will also be safer, and less liable to fly the track. He would, therefore, recommend that the committee and engineer be requested to procure from Pennsylvania, or Maryland, a double car of the most approved construction, and an order to be given to our manufacturers here to make 19 more to correspond.

With respect to the engines to be used west of the river, it should be borne in mind, that we shall doubtless have occasion for a considerable length of time to use 15 miles of the track of the Hudson and Berkshire Road, the flat bar rail of which is entirely inadequate to sustain a four wheel engine with 4 tons on each driver, and if we should order engines similar to those in use east of the Connecticut, they could not pass from Pittsfield to Albany. As the number upon our road will beincreased by the addition of two new engines from Lowell, and during the coming winter, it is not probable that more than one train per day will be required between Springfield and Chester, they would respectfully recommend that no more engines be ordered until farther experiments have been made, and farther information obtained, as to the costs of repairs.

All which is respectfully submitted by

(Signed) E. Hasket Derby.

A Minority of the Committee.

ON THE PRINCIPLES OF ELECTRO-MAGNETIC MACHINES.

Professor Jacobi, of St. Petersburg, infers, from his experiments, the following laws in reference to the magnetism developed by the application of the galvanic current.

1. The amount of magnetism produced in malleable iron by a galvanic current is proportioned to the force of the current.

2. The thickness of the wire composing a helix, and surrounding an iron rod, is of no consequence, provided the number of turns of the helix, and the force of the current, remain the same. With thin wires, however, a more powerful galvanic battery must be used, in order to overcome the resistance in the conductors.

3. Generally, in practice, the influence of the coil may be neglected.

4. The total action of the electro-magnetic helix upon the iron rod, or core, is equal to the sum of the effects produced by each coil separately.

5. The maximum of magnetic effect is obtained from a galvanic current, when the total resistance of the conducting wire, which forms the helix, is equal to the total resistance of the battery.

6. When the diameter of the iron cylinder forming the core of the helix is increased, the length remaining the same, the force of magnetism developed by a given current is increased in the same proportion.

7. A variation in the length of the core only influences the result by admitting a greater number of turns of the helix upon it.

8. The attraction of electro-magnets is proportional to the square of the force of the galvanic current, by which they are formed.

In the last trials made in propelling a boat twenty-eight feet long, seven and a half wide, and drawing two feet and three quarters of water, on the Neva, a velocity of three miles an hour was kept up. The boat carried twelve to fourteen persons. Professor Jacobi remarks that this is the velocity attained by the first steamboat.

In reference to the practical application of electro-magnetic power, Professor Jacobi gives the following rules. 1st. The maximum of mechanical effect is proportional to the square of the number of voltaic elements, multiplied by the square of the electromotive force, and divided by the resistance of the voltaic circuit. The co-efficient by which these values must be multiplied to give the effect, depends upon the quality of the iron forming the electro-magnets, the form and arrangement of the rods, and the distance between their ends. A battery of platinum and zinc plates produces two or three times the effect of a similar one of copper and zinc. 2nd. The force of the machine varying directly as the square of the number of coils in the helix, and the velocity inversely as the same square, the maximum power is independent of this number. It is also independent of the dimensions of the electro-magnetic rods. 3rd. The attractive force of the electro-magnets, or pressure of the machine is proportional to the square of the force of the current. 4th. The economic effect, or the available power divided by the consumption of zinc, is expressed by the relation between the electro-motive force and the co-efficient spoken of under the first head. 5th., The consumption of zinc while the machine is at rest is double that when producing the maximum effect.

Professor Jacobi concludes his remarks thus:—

"I consider that there will not be much difficulty in determining with sufficient precision the duty of one pound of zinc, by its transformation into the sulphate, in the same manner that in the steam engine, the duty of one bushel of coal serves as a measure to estimate the effect of different combinations.* The future use and application of electro-magnetic machines appears to me quite certain, especially as the mere trials and vague ideas which have hitherto prevailed in the construction of these machines, have now at length yielded to the precise and definite laws which are conformable to the general laws which nature is accstomed to observe with strictness whenever the question of effects and their causes arise. In viewing, on the other hand, a chemical effect, the intermediate term scarcely presents itself. In its present case, it is magnetic electricity, the admirable discovery of Faraday, which we should consider as the regulating power, or, as it may be styled, the logic of electro-magnetic machines."

* It may be recollected by our readers that we pointed out a method by which the expense of working an electro-magnetic engine might be estimated in our article upon that subject, published in 1839. It is gratifying to find that men of science are pointing to this as the true method to ascertain the real progress of the invention. That the "duty" may be ascertained from the same data is but a consequence of the positions of Prof. Jacobi.

A PROSPECTIVE VIEW OF PENNSYLAANIA IN RELATION TO HER SYSTEM OF INTERNAL IMPROVEMENTS, WITH SPECIAL REGARD TO THE PROPOSED PHILADELPHIA AND PITTSBURG RAILROAD.—*No.* 2.

The natural advantages which have decided the location of commercial cities, and have administered to their growth and prosperity, it is true will always continue to operate in their favor. The easier access of Baltimore to the sea constitutes one of its natural superiorities over Philadelphia. But, on the other hand, we must admit, on the authority of experience, that such natural advantages may, in a very considerable degree, be counterbalanced, first, by the influence of superior capital, and secondly by the effect of artificial communications.

Steamships may reach as readily the port of Philadelphia as the port of Baltimore, or other commercial places, and we can by means of railroads form all the connection with the interior we may desire.

Let us now look into the merits of the proposed route for a continuous railroad from Philadelphia to Pittsburgh, and examine what its prospects are when compared with rival routes.

The distance by the Baltimore and Ohio railroad from Baltimore to Pittsburg, according to the last report of the engineers on that work, will be three hundred and forty miles. There are numerous steep grades upon that line, particularly in the mountain section. There occurs on the eastern slope of the Alleghany mountain a grade of sixty-six feet per mile of twenty-two miles in length. A similar steep grade will occupy the western slope, but only to a small extent. There are also steep gradients and short curves between Harper's Ferry and Baltimore.

Now, according to the report of the engineer, the distance from Harrisburg to Pittsburg, by the preferred route, called the middle route, which runs up the valley of the Juniata and Little Juniata, and ascends by the slopse of the latter stream the summit of the Alleghany mountain, thence descends to Ebensburg, and pursuing the valley of the Black Lick, crosses the Conemaugh river below Blairsville, and continues in a very direct course through the county of Westmoreland, and by the valley of the Monongahela, finally reaches Pittsburg. The whole distance by this route is two hundred and forty-two miles, and adding to it the distance from Philadelphia to Harrisburg, of one hundred and sixty miles, we have the total distance from Philadelphia to Pittsburg, three hundred and forty-eight miles, with no grades exceeding forty-five feet per mile, and but a very moderate proportion of curvature.

We understand, however, from a private conversation with the Engineer, that there are reasons to believe that a farther saving of distance of about ten miles may be effected by more minute surveys, and thus the whole distance would be reduced to three hundred and thirty-eight miles, two miles less in distance than the line from Baltimore to Pittsburg. But we all know, that in comparing two lines of railroad, we have to consider the gradients as well as the distance.

The total rise and fall on the Philadelphia and Pittsburg line will be considerably less than on the Baltimore and Ohio line, and the grades on the former route are not as variable as on the latter. Thus it is established by the Engineers that the virtual distance from Baltimore to Pittsburg will be greater than from Philadelphia to Pittsburg, and that, therefore, Philadelphia can compete successfully with Baltimore in the advantageous transportation of goods and passengers to the west, vice versa.

Now let us turn our attention to New York. This commercial emporium has been aroused from its lethargy by the efforts of Boston in forming a continuous railroad communication to the lakes, and is now actively engaged in prosecuting with vigor the New York and Erie Railroad and the New York and Albany Railroad, and the good earnest which they show in this cause, leaves little doubt that these two lines will be completed at an early period.

It is stated by Mr. Schlatter, that when Cleveland on Lake Erie, is taken as the western termination of the different routes, the distance from New York to Cleveland by the New York and Erie Railroad, and thence by the Lake, is 654 miles. The distance from Cleveland to Pittsburg by railroad is estimated at one hundred and thirty miles, which makes the total distance from Philadelphia to Cleveland four hundred and seventy-eight miles, therefore one hundred and seventy-six miles less than from New York to Cleveland. At the same time, it should be remembered that the grades upon the New York and Erie Railroad will be less favorable than upon the Philadelphia and Pittsburg Railroad.

The nearest route from New York to Phiadelphia is eighty-five miles. Add to this four hundred and seventy-eight miles, and we have the total distance from New York to Cleveland, via Philadelphia and Pittsburg, five hundred and sixty-five miles, therefore ninety-one miles less than the distance by the New York and Erie Railroad.

What inferences are we to draw from these important facts? Nothing han that, in the natural course of things, when a continuous line of railroad shall be establihsed from Piladelphia to Cleveland, via Pittsburg, the New York merchants will send their goods to the west by way of Philadelphia, and that the Philadelphia merchants who import their goods directly, will have a decided advantage over those of New York.

The construction of a railroad from Pittsburg to Cleveland, will, there is no doubt, be undertaken as soon as the Harrisburg and Pittsburg Railroad is commenced. But even before that work should be completed, the conveyance of goods and passengers from Pittsburg to Cleveland can be effected by the Beaver Division Cross Cut and Ohio Canal at an increase of distance of about twenty-five miles.

We should therefore bear in mind that the transportation of goods and passengers by railroad from the east to the Ohio river and the lakes, will chiefly take place upon the Philadelphia and Pittsburg Railroad. New York cannot help, in this respect, to pay a heavy tribute to Philadelphia. Thus the citizens of our metropolis will have it in their power to control a very large amount of the western trade, *if they choose, and are willing to do their duty.*

The reason why Cleveland is taken as a point for the lake trade, is obvious. The harbor of that city is open at an earlier period than all the other ports on the lake. Railroad lines are in comtemplation from Cleveland farther west, and we shall eventually have a continuous line from Philadelphia to Chicago and to the Mississippi.

When the town of Erie is assumed as the terminus of different rival routes, and we suppose a branch of the Philadelphia and Pittsburg Railroad should leave the main line at the mouth of the Black Lick, and thence following the Kiskeminetas and ascending by the Buffaloe Creek, and following the direction to Franklin and Meadville, terminate at Erie, then the total distance from Philadelphia to Erie by this route is estimated at about four hundred and eighty miles, which estimate will not be far from the truth.

On the other hand, the length of the New York and Erie Railroad is four hundred and eighty-four miles. Adding to this the fifty miles distance from Dunkirk, (which is the termination of the New York and Erie line,) to the town of Erie, we have five hundred and thirty-four miles as the total distance from New York to the latter place, via New York and Erie Railroad.

The difference of distance in favor of the Philadelphia route over the New York route would therefore be fifty-four miles.

Considerations of so vast importance should certainly not be trifled with; they deserve to be carefully weighed in order that we may be enabled to arrive at sound conclusions. We should not leave to chance what we have in our power by well directed efforts to control.

The city of Boston is trying her utmost to complete a continuous line of railroad to the lakes, and another year will have accomplished this gigantic undertaking.

The distance from Boston to Albany by the Worcester and the Western Railroad will be two hundred miles. The distance from Albany to Buffalo and thence to Cleveland is five hundred and twenty-five miles, which makes the total distance from Boston to Cleveland seven hundred and twenty-eight miles, or two hundred and fifty miles more than from Philadelphia to Cleveland. Boston therefore cannot begin to compete with Philadelphia for the Cleveland and far western trade. Is this not also a strong argument in favor of establishing a line of steamers between Philadelphia and Europe? Is Philadelphia determined to become paralyzed by the energetic efforts of her neighbors, and this, too without even making an effort to compete? The tendency of the present age is evidently progressive. While we are surrounded on all sides by active vigor and intellect we cannot pause to reflect, *but we must go on*, and reflect while on our march.

REPORT OF ELLWOOD MORRIS, CHIEF ENGINEER OF THE CHESAPEAKE AND OHIO CANAL.

CHESAPEAKE AND OHIO CANAL LINE,
December 31*st*, 1840.

(Concluded from our last No.)

Some curiosity having been expressed with regard to the probable detention at, and the mode of transit through the tunnel, I propose, before dismissing this subject, to dwell briefly upon both.

The canal for some distance both in approaching and leaving the tunnel, has from economical considerations been planned with a single boatway, as follows:

	Feet.
Canal contracted to a single boatway adjacent to the south portal,	200
Tunnel, (in length)	3118
Canal contracted to a single boatway adjacent to the north portal,	894
Total length of canal contracted to a single boatway,	4212

The speed of loaded boats upon canals is usually taken at $2\frac{1}{2}$ miles per hour, and this may be considered as the maximum pace of fully freighted boats. Owing to the contraction of the waterway and other causes in the tunnel, the progress of boats in their transit through will be slower than upon the open canal, and will not probably exceed the rate of $2\frac{1}{4}$ miles per hour, or 198 feet per minute.

A single passage through a lock of 8 feet may be practically regarded as requiring upon an average 5 minutes, and an alternate or cross passage of two boats 10 minutes.

Hence with single locks (which case only I shall here consider) if the canal were working at its utmost capacity, it would, upon the snpposition of uniform motion, bear upon its bosom during the season of trade, an ascending and a descending procession of boats moving at intervals of 10 minutes apart, passing each other alternately, and locking in alternation: consequently 12 boats, or 6 proceeding in each direction, would pass a fixed point during every hour.

Having thus premised, I will observe that it is so evident that in order to save time, boats must pass the tunnel in convoys of several, that it is unnecessary to establish that fact in calculation; the only question is how many boats ought each convoy to consist of when the canal is working at its maximum rate with single locks, and consequently when boats are successively arriving at both portals, at intervals of 10 minutes apart?

The answer is—that the proper number will depend directly upon the time requisite to move twice through the contracted canal and draw out past a waiting convoy, or in fact directly upon double the length of the single boatway and convoy in waiting.

For the sake of brevity, I will assume the length necessary to accommodate a waiting convoy at 1200 feet; then as this convoy, by lying along the beam side, would contract the canal to a single boatway for that distance, we shall have:

	Feet.
Length of tunnel and canal constructed to a single boatway,	4212

Length of convoy in waiting, (and also contracting the canal)	1200
Total length of single boatway in effect,	5412

Now to traverse 5412 feet, *twice*, or 10,824 feet, at our assumed pace of $2\frac{1}{4}$ miles per hour, or 198 ft. per minute, would require 55 minutes, and allowing 5 minutes for starting the convoys at both ends and for lost time, we shall have as the period occupied in a double transit, 60 minutes.

To prevent meeting, evidently no boats can be permitted to enter either portal from the moment a convoy in one direction leaves, until the returning one moving in the other has drawn out of the tunnel; hence if we imagine a boat to arrive at one portal the instant a convoy has departed, she would be compelled to wait 60 minutes before her time for passage, as the leader of the next convoy would arrive: during this space of time 6 boats would collect, and that is the proper maximum number for a convoy to pass this tunnel upon the hypothesis assumed.

If the canal had double locks, the convoy should consist of 11 or 12 boats, and the passages still be hourly. Boats then ought to be passed through this tunnel both ways *at every hour*, and with an active trade it would be necessary to have a superintendent stationed at each portal to regulate the hourly transits, and perhaps also to provide gates or some other barrier under his control, to be opened *hourly* to admit the entrance and exit of convoys.

The hours fixed for the transit of convoys both ways should be regularly notified to the boatmen in print—thus:

Descending convoys will leave the south portal of the tunnel at 8 A. M.; 9 A. M.; 10 A. M.; &c.

Ascending convoys will leave the north portal of the tunnel at $8\frac{1}{2}$ A. M.; $9\frac{1}{2}$ A. M.; $10\frac{1}{2}$ A. M.; &c.

All boats presenting themselves for passage, to conform strictly to the instructions of the tunnel superintendents, and haul into such positions as they may indicate. If boats should arrive at either portal when no convoy was forming at the other, and no boats then e in sight, a system of signals could easily be concerted to communicate that fact, and the arriving boat in such case be allowed by the superintendent to proceed without any delay.

It is evident from what has been said that the utmost detention that any boat can experience will be 60 minutes, whilst a boat arriving just as a convoy in the same direction was setting out, would join its rear, and not be detained at all; hence the average detention may be assumed at thirty minutes, which enables us to ascertain the real or effective saving in distance caused by the adoption of the tunnel route for the canal, in lieu of that located around the Pawpaw Bends.

	Miles.
A canal around the Pawpaw Bends would be in lentgh,	$6\frac{1}{2}$
The tunnel line (including cuts, &c.) is, to the same points,	$1\frac{1}{2}$
The saving in measured distance being	5

Now, during the 30 minutes average detention, a boat proceeding at the rate of $2\frac{1}{2}$ miles per hour, would move upon the open canal $1\frac{1}{4}$ miles; therefore, the virtual saving of distance produced by the tunnel route, when equated by the average loss of time is, 5 miles minus $1\frac{1}{4}$ miles or $3\frac{3}{4}$ miles* saved in effect.

* Strictly the virtual saving would be a little less, owing to the greater speed upon the open canal.

Such are the theoretical results upon a fixed hypothesis, that establish the limits of this subject, which of course in pratice will be modified by many causes; and I will now dismiss the matter with the observation, that though the deductions in this connection might be both more briefly and vigorously developed by mathematical formula, yet I have preferred the more familiar explanations given above as best suited to the present purpose.

* * * * * *

Summary of the Locks and Levels on the 50 Miles.

No. of Level below Cumberland.	No. of Lock and Level above George Town.	Lift of Lock. Feet.	Length of Level. Miles.	Length of Level. Feet.	REMARKS.
1	75	10	8	4282	From the 75th to the 72d Level, inclusive, the chief part of the Masonry is now finished.
2	74	10	0	850	
3	73	9	0	579	
4	72	9	1	145	
5	71	8	6	4867	
6	70	8	0	1708	
7	69	8	0	1405	
8	68	8.258	1	3052	From the 71st to the 58th Level, inclusive, the Masonry is exceedingly backward, being in fact scarcely begun..
9	67	8	3	702	
10	66	now converted into 4 Locks each, of 10 ft. = 40 Lockage.	7	513	
11	65				
12	64		0		
13	63			1638	
14	62				
15	61	8	1	1916	
16	60	8	3	1807	
17	59	8	3	681	
18	58	8	2	2524	
19	57	8	4	3562	From the 57th to the 54th Level, inclusive, the Masonry is well advanced, and the most of it is now finished.
20	56	7.7	2	5264	
21	55	7.8	2	789	
22	54	7.8	0	600	
Total Lift and Length,		181.558	49	5204	Distance 50 miles nearly.

* * * * * *

There is another question involving grave considerations of cost and utility, which ought now to be presented to the directory; it is that of FEEDERS.

Before entering upon this subject, however, candor obliges me to admit, that the disposable time I have had to devote to this matter, has proved insufficient for the acquisition of sufficient instrumental data, to enable a final decision to be formed upon the merits of all the rival plans which present themselves and command our attention: indeed all that I can promise myself upon this occasion—with regard to such as possess equal merit—is to indicate the direction in which further examinations ought to be made: though it is true, that to some of the plans of feeding, such insuperable and manifest objections exist, that we may venture to reject them, without any further evidence.

By gauging the north branch of the Potomac, above Cumberland, and also Wills' Creek, during an extraordinary drought (September, 1838,) it was ascertained that the quantity of water then running in these streams was as follows:

			Cubic feet.
In the north branch, 19.6-10 cubic feet, per second, or per minute,			1176
In Wills' Creek, 3.6-10	ditto	per minute,	216
Total running supply per minute, entering the pool of the Cumberland dam, in September, 1838,			1392

The above gauge of the north branch, though taken with much care, was made by transverse sections and average velocities, upon an uneven site; it may, therefore, possibly err in deficiency: still, with a reasonable allowance for error, it indicates that the supply of water at Cumberland will be, in very dry seasons, entirely inadequate even to supply the natural consumption of the canal, without providing for the lockage of the trade.

This will more clearly appear, by considering the probable wants of the canal, *exclusive of lockage:* to arrive at a proximate valuation of which we must recur to experience elsewhere.

With this view I have compiled the following table, from a report of Frederick C. Mills, Esq., chief engineer of the Gennessee Valley Canal, made to the canal commissioners of New York, under date of January 23d, 1840, wherein he gives a general summary of those practical examinations which have induced the ablest engineers in that quarter to adopt as the measure of the loss of water upon canals, from every source of consumption (except lockage,) the rate of 100 cubic ft. per mile and per minute.

TABLE,

Compiled from the Report of F. C. Mills, Esq., Chief Engineer of the Gennessee Valley Canal, New York, 1840.

Consumption of Water upon finished Canals in New York—caused by evaporation, filtration, and the leakage and waste at the mechanical structures, as ascertained by the following Civil Engineers:—

AUTHORITIES.	Canal experimented upon.	Length of the part tested in miles.	Total consumption, exclusive of lockage, in cubic feet, per mile and per minute.
Judge Roberts,	Erie,	61	90.16
Ditto,	do.	11	100
Ditto,	do.	69½	116.54
Ditto,	do.	141½	103.18
Judge Bates,	do.	79	101.26
Ditto,	do.	20	105
W. H. Talcott,	Chenango,	22	107
8 different Engineers,	2 Canals,	404	723.14

Average of all the experiments, 103 7-10.

Mr. Mills further states that,

"Mr. Talcott's experiments show the loss on 22 miles of the Chenango canal to be 107 cubic feet per mile per minute; of which 66 cubic feet was for evaporation and filtration, and 41 cubic feet for leakage and waste at the mechanical structures; and by using those results as the basis of the calculations on the Gennessee Valley Canal, he makes the loss for the same causes 105 cubic feet: this small difference is owing to there being a less number of mechanical structures on the latter than on the former canal"

The experiments referred to above were made in 1839, and having been undertaken with the express view of acquiring data upon which to found an accurate calculation of the probable wants of the Gennessee Valley canal on 31½ miles of its length, which is to be supplied chiefly from reservoirs—being in fact designed to guide the expenditure of a large sum of money in such works, they no doubt received all that care and attention which an important object demanded, and which justifies an entire reliance upon Mr. Talcott's results.

Some persons may flatter themselves with the hope, that the consumption of water upon the Chesapeake and Ohio Canal may possibly be less than the above quotations would indicate: for my own part, the investigations of the skilful and experienced engineers of New York, verified as they have been by practice, command my confidence, and induce me without hesitation to assume, that this canal, like others elsewhere, will need, besides its lockage water, a supply from every feeder, equivalent to 100 cubic feet per minute, for every mile of distance fed.

To introduce an intermediate feeder from the Potomac, into the canal, between the mouth of the south branch and Cumberland, would, as the work has been planned, be impracticable without great expense; after passing Evitt's creek there, the neighborhood of the mouth of the South Branch is the first place where a further supply of water can be introduced.

From Cumberland to the South Branch, by the line of the canal, is near 19½ miles: this then is the distance to be fed from the drainage of the valley of the North branch.

Let us now consider the probable amount of water required for lockage; the whole of which, for the thorough trade, must be supplied from the 75th, or Cumberland level; and for this I shall assume the number of boats plying each day upon the canal near Cumberland at 120, (the same number adopted by the U. S. Engineers:) 60 being supposed to arrive and 60 to depart each day, their lockages being assumed to take place independently, and not by the "alternate passage."* These boats, if of 75 tons, would be competent to carry downward, during the navigable season, one million of tons, and would draw from the Cumberland dam per day, for lockage 120 times the prism of lift of lock, No. 75, of which, in the face of a probable deficiency of water, I find, with surprise, the lift to be established at 10 feet, the maximum in use upon the canal.

Lockage water required for the assumed trade.

$100 \times 15 \times 10 \times 120 = 1{,}800{,}000$ cubic feet per day, or 1,250 cubic feet per minute.

Consequently, with such a trade, the wants of the canal from Cumberland to the South Branch, would require, to satisfy every cause of consumption, the following uniform supply of water:

	Cubic feet.
Per minute for lockage, at 120 locks full per day,	1,250
Per minute, for all other sources of loss upon 19½ miles, at 100 cubic feet per mile and per minute,	1,950
Demand of the canal per minute,	3,200
Supply of running water entering the Cumberland dam in the driest seasons (as before stated) per minute,	1,392
Deficiency per minute, during extreme droughts,	1,808

It is proper to remark that we are dealing with extremes in this connection; for in ordinary seasons I doubt not that the supply of water at Cum-

* This assumption is made in order to cover the maximum expense of water, though I doubt not that during an active trade many "alternate passages" would be made.

berland will be enough to enable a moderate use of the canal, as low down as the South Branch. It is only in droughts that it would so completely fail to supply the trade. And if it be asked how, upon such occasions, this prodigious dry weather deficiency is to be made up? the answer is, only by reservoirs upon Evitt's or Wills' creek, or both: for to introduce Evitt's creek as an ordinary feeder, whereby 432 cubic feet per minute might possibly be added to the supply, would not reach the root of the evil, and would still, in dry weather, leave a large deficiency unprovided for.

It would, however, be prudent policy to defer the construction of any of these auxiliary works, until, by the opening of the canal, its exact consumption (clear of lockage) can be ascertained by actual experiment.

The probable deficiency of water in the North Branch at Cumberland, to supply the consumption of the canal and the lockage of the trade upon 19½ miles, or in dry seasons even the consumption alone upon that length of canal, indicates most clearly that unless the traffic upon this work is to be left, like the navigation of the river, dependant upon the clouds, an intermediate feeder between Cumberland and dam No. 6, will (to make the improvement perfect) be indispensable, even at the very first opening of the navigation of the new canal; and accordingly, whenever the directors are prepared to extend their operations, the *intermediate feeder* ought, in this view, to be one of the very first works let: for the idea of putting the canal into complete use through the medium of the Cumberland dam alone, must, it seems to me, in the face of the facts set forth, be necessarily abandoned: though a considerable Spring and Autumn trade might be thus maintained.

* * * * * *

3—*On the Condition and Prospects of the Finished Canal, now Navigated 134 Miles Upstream from Georgetown to Dam No.* 6.

It is gratifying to be able to state that upon the finished part of the canal during the past year, breaches have been less frequent than heretofore; thus indicating that the stability of the Banks is gradually augmenting by time, and the continual strengthening of weak points by repair, as fast as they display themselves by leaks or breaches.

The 4th division, being the 27½ miles next below dam No. 6, (with the exception of that work proving more leaky than was expected,) has during the past year fully retained its reputation for fidelity of construction, the navigation for the time it was open having, like that of last year, remained entirely uninterrupted; it must however be remarked that this division has never yet been tested by a full head of water. The costly improvements upon this part of the line made during this year, at the pool four miles below Hancock, and in the limestone district near Prateas Neck have (I understand) thus far answered the expectations which were formed of their utility.

The two extensive pools upon the 4th division, at Mrs. Bevans', 4 miles below Hancock, and at Fort Frederick below Licking Creek, especially the latter, will need additions to their embankments to enable them to carry safely 5 feet water; the banks should receive more internal base, be augmented in height, and armed upon their faces with a Riprap; the superintendent of the 4th division has been injudiciously directing his attention to these points.

The necessity of elevating the Towpath Bank of the Fort Frederick Pool, and protecting its interior face with rock, will be gathered from a mere statement of the fact that it is about 2 miles long in a right line and 20 feet deep or more, giving manifestly both scope and depth enough to enable a heavy gale of wind to create a sea, which I apprehend deeply freighted canal boats will sometimes find it difficult to weather: these surges rushing with violence against the towpath, would evidently breach it very soon, if not provided with a suitable defence.

Every objection which can be properly urged against River Slackwater Pools, (except current) lies with much greater force against that at Fort Frederick, because the latter runs in a straight line, and is therefore liable to be swept by gales from end to end; whereas a river pool is almost always land locked by its own curvature, it being a rare instance in which the wind would have a fair sweep over 2 miles lineal of water where the depth at the same time approximated to 20 feet; even the very trees which fringe a river bank would shield the pool to leeward: and it is a well known fact that a gale of wind, to raise formidable waves, must have both free range of surface and depth of water to operate upon; for depth is necessary for the action of those peculiar oscillations which form waves, and scope is requisite to give time for the rushing air to draw the particles of water into motion.

There is, however, another important advantage which pools within a canal must always possess over a river slack water, and this is, that the level of the canal water remaining fixed, the towpath of course is never liable to overflow.

A vicious plan of taking earth for repairs from places already weak, (merely because the land happens to belong to the company,) has occasionally upon sudden emergencies been practised—indeed necessarily so—by the superintendents.

The remedy for this is plain: the company ought at suitable points upon the beam side of the canal, to acquire by purchase small lots of ground, whence earth could be conveniently taken for repairs; and as a general rule, no material should ever be excavated for that purpose between the canal and the river, for in addition to the earth in such places being less accessible, its removal has a direct tendency to weaken the earth works of the canal.

So prodigious is the leakage of dam No. 4, 5 and 6, in their present imperfectly gravelled state, that during the past summer the water in their pools subsided so far below their respective combs, that for several weeks it was impossible to introduce more than about 18 inches depth of water over the mitre sills of the Guard Locks, though their gates were thrown wide open for the purpose.

Of course the navigation upon the feeder levels of these dams could not be maintained, and was necessarily suspended for some time. This result was not unexpected at dams No. 4 and 5, but certainly unlooked for at dam No. 6, which, having been built in a much more careful and costly manner, it was reasonable to expect it to be more retentive of water.

Candor, however, requires the remark, that neither of these dams have ever yet been gravelled to a necessary extent, which, if properly done, ought to prevent leakage sufficiently, and which I would respectfully advise, should be completely done at the earliest practicable period, as the annual exposure of the dams to the summer's sun must, of necessity, cause *the rot* to destroy them with great rapidity.

Under present circumstances, the leaks in each of these dams seem to be just about sufficient to pass under a head of 15 feet, the entire summer flow of the the Potomac during a dry season leaving 5 feet of the crest of each work exposed for some weeks in almost every year. This indicates dam No. 6 to be the tightest of the three, as the river is considerably smaller at its site than it is at the locations of others.

The heavy ice freshet of February, 1840, made a large breach in dam No. 4, which has been successfully repaired during the summer and autumn, by the superintendent of the 3d division; who has also replaced a large portion of the down stream sheathing (which had been injured) with 6 inch plank, which will be a decided improvement, as the old 3 inch sheathing was entirely too light to withstand the tremendous reaction of drift which the figure of the dam causes to take place during freshets with extraordinary violence, both here and at dam No. 5. Indeed it remains to be seen whether even the 6 inch sheathing will prove entirely successful in resisting those assaults which a radical defect in the figure of the overfall profile necessarily produces.

It was to have been expected that the maintenance of dams of sufficient dimensions and extent to bridle a river so formidable during freshets, and rapid in its downward course from the mountains, would be expensive: it will not therefore be a disappointment to know that the day is not far distant when both dams No. 4 and 5 will need extensive repairs; and this period has not been a little hastened by the summer exposure before alluded to. Whenever these large repairs are made, which ought to be taken in hand in time, I would recommend that the profile of those works should be altered, so that the overfall may be nearly perpendicular, which will destroy the reaction that now takes place during floods.

The experience of the last few years indicates, in a decided manner, that the traffic of the country bordering upon the Potomac, or what may be called the "*way trade,*" will be able to pay all the expenses of the company and keep the canal in repair. This is a very satisfactory prospect, as it will leave the tolls upon the *thorough trade* from Cumberland, to enter the treasury of the company unencumbered by charges; and hence all the revenue so derived will be clear profit.

With the view of elucidating some of the subjects treated in this report, I addressed a few interrogatories to the four Superintendents of finished canal, which, with the responses of those officers, I have embodied for the information of the Directors, in the following tabular statement. (See next page.)

As it appears from this table (and from my own knowledge) that never more than 4 to 4½ feet water has yet been maintained in the 4th Division, and as from its costly and careful construction we have a right to expect that it will better carry 5 feet water than any part of the canal, I accordingly respectfully advise that the Superintendent of the 4th Division be instructed, upon the opening of the navigation in 1841, or soon thereafter, to put up all the levels between Dams No. 5 and 6, to the full depth of "*five feet,*" and to maintain that depth during the navigable season.

I had intended to have gone carefully over the finished work, and personally examined every part of it in a thorough manner, previous to making this report; but a want of sufficient time upon the present occasion absolutely precluded me from putting that purpose into execution, and has compelled me to content myself with furnishing much more meagre information concerning the finished canal, than had been either designed or wished.

In conclusion, I may observe generally of the 134 miles of canal now navigable, that with trifling exceptions, *its condition is good, and its prospects satisfactory.*

All which is respectfully submitted by

Your most obedient servant,

ELLWOOD MORRIS,

Chief Engineer.

STATEMENT.

No	QUERIES BY THE ENGINEER. Substance.	John Y. Young, Sup. of the 1st Division, answers:	Wm. O'Neall, Sup. of the 2d Division, answers:	John D. Grove, Sup. of the 3d Division, answers:	Joseph Hollman, Sup. of the 4th Division, answers:
1	What average depth was maintained in your levels during the past seasons?	5 to 6 feet.	4 1-2 to 6 feet.	4 1-2 to 5 feet.	4 1-2 feet.
2	Were embankment breaches more or less frequent this year than heretofore?	Less frequent.	Only one branch since I came into office.	Less frequent.	Neither leak nor breach has occurred this year.
3	Does your division annually become stronger?	The weak parts having been strengthened gradually, I answer yes.	Yes.	Yes.	Yes, except the two large pools.
4	Are the mechanical structures upon your division now in good repair?	Yes: the lock gates having been renewed. The wooden bridges are in bad order.	Yes, except lock gates.	Yes, except lock gates.	Yes, all.
5	Would all the levels of your division now bear "five feet" depth of water?	Yes, with safety.	Yes, with a small outlay upon banks.	Yes, I think so.	Yes, with safety, except the two large pools.
6	Will the revenue of the present fiscal year, ending May 31st, 1841, exceed or fall short of that of the last fiscal year?	Probably exceed that of last year.	Unable to form an opinion.	I think it will be near the same as last year.	Probably exceed that of last year.
7	Is your division now in good repair or not?	Yes, generally.	It is in good repair.	It is in good repair.	It is in good repair except those pools.

AMERICAN RAILROAD JOURNAL, AND MECHANICS' MAGAZINE.

No. 9, Vol. VI. New Series. | MAY 1, 1841. | Whole No. 381. Vol. XII.

PERFORMANCE OF LOCOMOTIVE ENGINES.

There can be no better evidence of the recent improvements in the construction of Locomotive Engines, than the narrow limits within which the maximum efforts of the engines of the best construction are confined. Hence there arises a keen contest for the superiority, and when the data of the performance are not complete, and they seldom, if ever are, it is no difficult matter for either party to show by the aid of apparently very exact calculations, that they have carried off the palm. The reports of the majority and minority of a committee appointed by the Western railroad Corporation, to attend the trial of the "America," built by Mr. William Norris, of Philadelphia, are striking illustrations of this fact. Our readers have had laid before them two statements containing the substance of the report of the majority of the committee (the report itself not being in our possession) and that of the minority.

Before proceeding to discuss these papers we beg leave to offer a few remarks upon the observations appended to one of these statements by George W. Whistler, Esq., Civ. Eng. W. railroad. The position taken by Mr. Whistler is this, that the *effective* power of any two engines is in direct proportion to the available weight for adhesion, or in other words, to the weight upon the driving wheels. This, we presume, no one will pretend to dispute, but we are not quite so willing to agree with the inference which we understand to be drawn, viz., that all engines being built upon nearly the same principles, and producing their effective power merely by the weight upon the drivers, there is no reason why we should attribute a *peculiar* power to engines of any particular construction. Now although we are perfectly willing to admit the absurdity of supposing that there can be a peculiar power of adhesion or counter gravitation, yet we must confess that the experiments (admitting them to be correct) do prove a peculiar power of increasing the weight of the drivers in the Norris Engine. We are opposed to all mystification upon such subjects, and there is no doubt that wherever it has been attempted, discredit has been attached to statements really true. We have taken some little pains to inquire into the peculiar construction of several of the different engines in use, and feel satisfied that it is easy to account for the extraordinary power which certain engines have of producing a greater adhesion than the ordinary observation would lead us to expect, or even than the most careful weighing would indicate. It is no business of ours to publish what engine makers have to keep secret, although we are not indebted to them for the discovery. The thing is so evident that any one may notice it. We have said that we are opposed to mystification, and were there any necessity, we should feel no hesitation in discussing the matter very freely. Having labored against popular prejudice, to prove that American Locomotives were equal, if not superior in construction to those made abroad, it would be unfair to decry any one of the many well made patterns in use among us. We have no interest in any one of them, and are very glad to see them all do their best.

At the trial on the Western railroad the engines used were the "*America*," built by Mr. William Norris, of Philadelphia, and the "*Suffolk*," built at Lowell. The loads drawn over a grade of 66 feet to the mile, prove that they were both well built engines, and capable of answering the purpose of a heavy traffic. The effective power of these as estimated by the majority of the committee was ascertained by an experiment which we conceive to have been improper for that purpose, and that such was the fact we shall endeavor to prove from the experiments themselves.

The mode of connection in the tender of the *America* led the committee to suppose that when in action, an additional weight would be thrown upon the drivers. To verify this, the engine and tender were made fast, and the drivers were weighed under a full head of steam, the forward wheels were likewise weighed under the same circumstances. This operation was repeated upon the "Suffolk." The results are as follows:

America.

Weight on forward wheels, *without* steam,	11,590 lbs.
Do. do. do. *with* steam,	9,650
Difference,	— 1,940

Weight on driving wheels *without* steam,		18,620
Do. do. do. *with* steam,		20,010
Difference,		+ 1,390
A second weighing gave		
Weight on driving wheels *without* steam,		19,220
Do. do. do. *with* steam,		21,070
Difference,		+ 1,850
Total weight of engine,	29,241 lbs.	

Suffolk.

Weight on driving wheels *without* steam,		16,075 lbs.
Do. do. do. *with* steam,		17,150
Difference,		+ 1,075
Weight on forward wheels *without* steam,		7,480
Do. do. do. *with* steam,		5,700
Difference,		— 1,780
Total weight of engine,	23,630	

Of the difference between the first and second weighing of the *America*, it is remarked that notwithstanding the addition of the weight of the fireman and engineer, the discrepancy is too great, and as the second was made with great care, it would appear that the first was erroneous. Both weights, however, were used to obtain the mean.

With all due difference to the judgment of those who instituted this experiment, we cannot but consider it as inexact and totally devoid of reliance. The operation of weighing the drivers of a quiescent engine is liable to error unless carefully performed, but it appears to us next to impossible that any information can be obtained when the full head of steam is applied to a powerful engine. We have not heard a single opinion to the contrary from any one with whom we have conversed on this subject. Engineers, manufacturers and scientific men, having no interest in the question have with one voice pronounced the experiment improper.

In the first place the moment of taking the weight may have considerable influence, and this is admitted in one of the reports. "The difference in these weights under the pressure of steam may be attributed to the different positions of the cranks at the time of weighing, since the effects would vary from a maximum to nothing, depending upon their position."

The difference in the America referred to, amounts to 1060 lbs.

Moreover the friction upon different portions of the wheels may differ considerably and vary the result, as the actual velocity at the time of taking the weight may be greater or less than the average velocity of the engine upon the road. In the second place, apart from all fluctuations during the continuance of the same engine upon the platform, the comparison between two engines can never be exact. Can it be as certain that the tangential point upon the platform is precisely the same?—and if it is not the same how can we estimate the difference of the friction at different points? a spot of oil or a slight irregularity in the point of support would materially vitiate the results. If in weighing the same engine a difference of 1,060 lbs. occurs, may not the comparison of engines of dissimilar size and construction, vary several thousand pounds? In this experiment the diameter of the drivers was not the same—another source of error. The tenders were chained to the track—and being of entirely different patterns, the circumstances were totally unlike in the two cases and undoubtedly produced a still greater departure from the truth.

If we had two simple and perfectly made machines, with polished wheels bearing upon a polished surface, weighing but a few ounces and both as nearly alike as the most skilful workman could make them, an experiment analogous to the one we are discussing might give results differing but a few grains. Instead of this we have not ounces but tons; engines of different size, weight and construction, the surfaces in contact purposely left unpolished, and in short every source of error carried out to the extreme case, and not one single mitigation to be found.

But it is by no means necessary to resort to theoretical considerations in order to prove the unsatisfactory nature of the experiment, the results actually obtained are sufficient to overthrow any deductions made from them. It will be seen that in both cases the increase of weight upon the drivers is less than the diminution of weight upon the forward wheels, or in other words that *the entire weight of both engines was diminished while under a full head of steam, the America losing* 550 *pounds and the Suffolk* 705 *pounds;* a result worthy of further consideration, as it still encourages "expectations that could never be realised without some special dispensation of the law of gravity." It cannot be said that these are trifling discrepancies, for the amount is in one case $\frac{550}{1390}$ and in the other $\frac{705}{1075}$ of the very effect which these experiments are intended to prove. If the palpable and evident error is from about one half to three-fourths, how much of the remainder is to be allowed for all other sources of inaccuracy?

A more striking proof of the great caution necessary in trusting to the most elaborate calculations, is to be found in the different deductions from the same data in the two statements of Messrs. Whistler and Jackson. The former has proved that in proportion to the adhesive force the performance of each engine, was as it should be—equal. The latter has proved that in proportion to the weight upon the drivers the *Suffolk* carried 16,314 pounds more than the *America!!* showing the *Suffolk* to have possessed in this trial a "peculiar power" (independent of adhesion) to the amount of 8 tons and over.

But notwithstanding the close calculations of these performances, one important datum is omitted, and never hinted at. We refer to the gravity of the engines which on an inclined plane is part of the load as much as that of the tender or of one of the cars. The difference of the weight of the two locomotives is either 5,510 or 7,180 pounds as the first or second weight of the *America* is taken. This should have been added to the load of the *America* making an increase of about 3 tons.

The pressure in the boiler is only mentioned at the end of the paper, as being 90 pounds in the *Suffolk*, and 130 pounds in the *America*, whether this is intended as the average or not we cannot say, it certainly is not meant to state that this was the uniform pressure throughout the trial as this is manifestly impossible.

We have thus minutely criticized these reports as they are put forth for the very purpose of disabusing popular prejudice, and aiming at great exactness, it is necessary that such exactness should be established before the results can be relied upon. One thing is certain, that what is intended to be proved is not proved, and the whole argument and calculation falls to the ground. If the observations of Mr. Jackson are correct, there *is* such a thing as a peculiar power of engines independent of adhesion, as shown in the *Suffolk*, and therefore those who are in search of such a power can justly appeal to his statement to prove its reality. But if Mr. Whistler is correct, the addition of three tons extra weight carried up by the *America* destroys the balance and give a peculiar power to the *America*, showing a total disagreement of any of the results drawn from the experiments.

It may be thought that we have devoted too much time and space to the consideration of this subject, but when the importance of the discussion is considered, our professional readers will agree with us that it is of the highest importance, and deserving strict scrutiny. When popular error and absurd expectations are to be proven upon the community, by those who produce facts which they claim to be strict and without the influence of such error and absurdity, a disproof of these facts is rather apt to increase the popular prejudice. Hence the caution with which such facts are promulgated should be extreme, and a good case made out before coming out.

If any of our remarks, which have been written in haste, and without much opportunity for revision, should be found inaccurate, we shall be greatly obliged for a correction. We always have professed and always have felt a desire for the promulgation of the truth, and are not the less inclined to it, when the correction of our own errors leads to such a result.

NEW YORK AND ERIE RAILROAD.

In a previous number we described the most northern of the three great railroad routes from New York city to Lake Erie, and presented profiles of each.

We now propose to make some remarks historical as well as descriptive relative to the second of the routes named, distinguished as the New York and Erie Road.

The attention of the public was first drawn to this route in the year 1839 by a pamphlet from the pen of W. C. Redfield, Esq. of New York city, a gentleman of enlarged views and scientific attainments, in which he proposed the construction of a railway, with a view of opening "a free communication at all seasons of the year between the Atlantic States and the Great Valley of the Mississippi." The city of New York on the East, and a point north of St. Louis, in the heart of the most fertile portion of the Mississippi Valley on the West, and designated as the two most important points to be united, and it was believed that a route nearly direct between these points could be obtained, which would pass north of the main body of the Allegany mountains, through the southern counties of New York, the northern portions of Ohio, Indiana, Illinois &c.

In May of the same year this project was examinned by E. F. Johnson, Esq. Civil Engineer, who took the same general view of the subject with Mr. Redfield, and in a communication prepared by him for publication discussed the merits of the project, entering at the same time somewhat in detail into a comparison of the relative merits of Railways and Canals.

The conclusion to which Mr. Johnson arrived on this latter subject may be stated in his own words as follows.

"That railways as a means of inter-communication, possess properties which in many situations will render them superior to canals, and that with reference to the United States, Railways when properly constructed, will be found the most valuable and effective, and that ultimately when their merits become better known and more fully appreciated, by far the greater portion of the inland trade will be conducted upon them."

This declaration it will be observed was made within three years after the completion of the Erie canal and when the capabilities of railways as a means of general traffic and travel had not been tested by experience. It is, indeed, worthy of note, how nearly this prediction has been verified in the lapse of only 12 years. The railways now in operation in the United States exceed 3000 miles in extent, and yield according to the statistics of De Gerstner, on the average 5½ per cent on their cost, after paying all expenses, and those in progress amount in the aggregate to about 2000 miles, while the canals at present constructing do not exceed, probably, one-fourth of that distance, and those which are completed are unable, with two or three exceptions, to sustain themselves and pay even a moderate interest on their cost.

To return now to our subject, Mr. Redfield published a second edition of his pamphlet in 1830, and in the same year a communication appeared in the Journal of Commerce from De Witt Clinton, Civil Engineer, in which a large portion of Mr. Johnson's remarks were embodied.

The latter were soon after published in full, in the Stateman, edited by Jno. I. Mumford, and subsequently were published by Mr. Johnson in pamphlet form, and distributed throughout the State at his own expense.

In 1831, the doctrine of internal improvement, by the general government, finding as it then did, considerable favor with the administration, Engineer Clinton was employed to make a reconnoisance of the country from the Hudson to the Mississippi, along the route of the proposed railway. His report was rendered in 1832, and exhibited in a satisfactory manner, the practicability of the undertaking, although the gneral features of the portion of the line within the State of New York were not quite as favorable as the friends of the project had anticipated.

In 1832, the charter of the New York and Erie Railroad Company was obtained, at the instance of several leading men in the city of New York, and in the interior of the State. This was the first important movement towards the accomplishment of the projected great line of railway, leading westward from New York city.

In 1834 the Legislature appropriated $15,000 towards a survey of the route. This survey was entrusted to B. Wright, Esq., whose report was made to the Legislature in the winter following. By this survey the distance from Tappan to Lake Erie was 483 miles, which with 24 miles to continue it to the city, made 507 miles for the length of the road, which distance it was stated might be reduced 10 to 15 miles or say, 495 miles in all. The cost of the road for a single track from Tappan to Lake Erie, was estimated at $4,762,260 or about $10,000 per mile. The survey proceeded from the Hudson river to the Ramapo near the New Jersey line, thence along the Ramapo valley, crossing the Delaware and Hudson canal, *through the interior* of Sullivan county to the Delaware river—along that river to Deposit—thence across to the Susquehanna at Binghamton and along the valley of that river, the Chemung, Canisteo and Allegany to lake Erie. The maximum acclivity of the grade lines on this road varied from 60 to 100 feet per mile, with an inclined plane for the use of stationary power near lake Erie of 506 feet elevation.

In August, 1835, Moncure Robinson and Jonathan Knight, Esq., Civil Engineers, were called to consult with Judge Wright. These gentlemen did not undertake to suggest any changes in the route surveyed, but in their joint report recommended the use of auxiliary engines upon the steeper grades, the construction of a tunnel at the Shawangunk ridge and the avoidance, if possible, of the inclined plane near lake Erie.

The estimated cost of the road was increased, and in this consultation $315,000, making the total $5,077,200.

It may not be amiss to stop a moment here, to say that it was in this year, that the celebrated act was passed, for the prosecution of the most hopeless project ever undertaken in the State, viz. the enlargement of the Erie canal—this year is famous, also, for the *ex-parte* report made by the Engineers then in the employ of the State, on the comparative merits of canals and railroads, giving of course the preference to the former.

Both the enlargement project and the report, were at the time severely criticised, the former in pamphlet form, and the latter in the Railroad Journal, the authorship of both which productions has been attributed to Engineer Johnson.

In the fall of this year, the grading of forty miles of the New York and Erie Railroad, from Calicoon to Deposit, along the Delaware river was advertised for and put under contract. The company also fixed the termini of the road at Tappan (now Piermont) on the Hudson river and at Dunkirk on lake Erie. The duties of

President of the company at this time, devolved upon Jas. G. King, Esq., of New York. The subscriptions amounted to $2,382,00 and the first annual report of the company was issued.

In 1836 the Legislature granted to the company a loan of the credit of the State to the amount of $3,000,000, which the company was to receive in two or three instalments, as certain divisions of the road should be completed.

This act of the Legislature gave to the New York and Erie Railroad a permanent place among the leading public works of the State.

Its ultimate construction was considered by its friends no longer doubtful, and as this event is an important one in its history, we shall avail ourselves of the circumstance, to terminate our remarks here for the present, to be resumed, however, in the next number.

The great length of the following report, has obliged us to present to our readers only those portions which give general views. It will be seen that great advantages will result from this investigation, to the present line of road, by doing away with all the inclined planes.

The successful examination of this intricate portion of country reflects great credit upon Mr. Schlatter, and his principal assistants, Messrs. *Stocker*, *Fox* and *Roebling*, who are deservedly complimented in the report.

SECOND REPORT OF CHARLES L. SCHLATTER, PRINCIPAL ENGINEER IN THE SERVICE OF THE STATE OF PENNSYLVANIA, TO THE CANAL COMMISSIONERS, RELATIVE TO THE CONTINUOUS RAILROAD FROM HARRISBURG TO PITTSBURG, (Read in Senate, Jan. 15, 1841.)

To the President and Board of Canal Commissioners:

GENTLEMEN:—Since my appointment of August 1, 1839, as Engineer, directing the surveys for a continuous railroad from Harrisburg to Pittsburg, instrumental examinations and locations upon the several routes, which were selected as presenting the most favorable features for a line of railroad, without inclined planes, have exceeded one thousand and sixty miles. Reconnoisances, to a great extent, have also been made on *nearly all* the routes which were recommended to my notice by citizens residing in the several counties, lying between the Susquehanna river and Pittsburg. I regret exceedingly, that I am not able to say *all* the routes, for I was most anxious that every one between the Susquehanna river and Pittsburg, which upon reconnoisance, appeared at all practicable, should be submitted to the test of instrumental examination, if only for the purpose of satisfying the minds of those citizens who are interested in the course of the projected railroad, and who call loudly for such information as will convince them, either that they have recommended the course of the best route on which the railroad should be constructed, or that they have been mistaken in their conclusions, when believing that the most feasible route is that in which they are interested.

The limited amount of the funds appropriated, prevented me from extending the surveys as far as I had intended; but by confining myself to what appeared the most practicable routes, I have been enabled to complete continuous lines from Harrisburg, to Pittsburg, by three grand routes, designated in my report of last year, as the Northern, Middle and Southern routes.

A recapitulation of the prominent features of these routes, will prevent the necessity of referring to the description given in my report to your Board, December 27, 1839.

A more minute detail will be given hereafter, whilst describing the progress of the surveys on each route.

THE NORTHERN ROUTE

commences at Harrisburg, and follows the valley of the Susquehanna to Northumberland, thence by the West Branch to the mouth of the Bald Eagle creek, and by the valley of the Bald Eagle, and one of its tributaries, to the summit of the Allegany mountain, where it passes through a depression known as Emigh's Gap, from thence descending the western slope of the mountain, it crosses the Moshannon creek, passes to the Clearfield creek, and follows that stream to its junction with the Beaver Dam branch, thence ascending the Beaver Dam branch, crosses the head waters of Chest creek, to the head waters of the Black Lick, descends the Black Lick, crosses the Conemagh near Blairsville, and pursuing a very direct course through Westmoreland county, strikes the Monongahela river at the mouth of Turtle creek, whence it is carried by the eastern shore of the river to Pittsburg.

THE MIDDLE ROUTE

will occupy the same ground as the northern route, from Harrisburg to the mouth of the Juniata river. Thence it diverges, and follows the valley of the Juniata river to its junction with the Little Juniata. By the Little Juniata and Sugar run, it attains the summit of the Allegany mountain, whence it passes west, through a depression two miles north of the Portage Railroad, known as Sugar Run Gap. From this point, two sub-routes have been surveyed; one by the Conemaugh, running nearly parallel with, and using a portion of the Portage Railroad, the other pursuing the course of the Black Lick; both routes crossing the Conemaugh, and joining the Northern Route near Blairsville, follow the line already described, to Pittsburg.

THE SOUTHERN ROUTE

is that projected from Chambersburg to Pittsburg, passing through the counties of Franklin, Bedford, Somerset, Westmoreland, and Allegany.

This route was surveyed by order of the Board of Canal Commissioners, by Hother Hage, Esq., principal engineer in the service of the State of Pennsylvania, during the summer and fall of 1838, and a line of railroad located, upon which no grade exceeded sixty feet per mile. This line, upon examination has been adopted, with but few variations; and the estimates, gradients and curvatures, with little alteration from Chambersburg to Laurel Hill, have been embodied in the material forming that portion of my report which relates to this route.

The surveys on the Southern Route, include the location of a M'Adamized road from Loudon, in Franklin county, to Laughlinstown, in Westmoreland county, prosecuted in accordance with a provision in the sixth section of "An Act to provide for continuing the improvements of the State, etc., viz: To complete the Survey of a railroad from Harrisburg to Pittsburg, * * * * * * and the engineer surveying the same, in connection therewith, is hereby authorized to make a survey to ascertain the practicability of a M'Adamized road of an easy grade, from some point at or *near* Chambersburg, to a point west of Laughlinstown." The perfect practicability of this road, has been ascertained, and the distance by the line surveyed with no gradient exceeding two and a-half degrees, (or two hundred and thirty feet per mile,) only exceeds that by the old turnpike, eleven miles.

The practicability of forming the road from Loudon to Chambersburg, is so well known, that I did not deem it necessary to carry the surveys farther than Loudon.

Owing to the great extent of the lines which have been surveyed, and upon which it will be necessary to make careful estimates of the cost, I shall not be able to lay before you the maps, profiles, estimates and comparisons upon the several routes, before April, when you will be enabled, beyond a doubt, to ascertain the various merits and demerits of each line, and to decide from facts which cannot be disputed, the route which should be recommended to the attention of the citizens of Pennsylvania. Local advantages and local interests, do not, in my opinion, properly pertain to the department of an engineer. Holding this opinion, and having been left untrammelled by intermediate points, between the place of starting and the destination of the road, I have endeavored, as far as lay in my power, to discover the nearest, cheapest, and best route for a railroad *between Harrisburg and Pittsburg.* It remains with your Board to decide which route would prove most *beneficial to the interests of the State,* as it is by no means certain that the shortest road would prove most profitable, for the resources of the country which may be developed by the longer line, might counterbalance and even exceed the advantages gained in distance, by the shorter, while many other benefits might arise in the course of the investigation between the rival lines, which may place the longer route in a position to be the most conducive to the prosperity of the Commonwealth.

The surveys this year were commenced early in the season, and as it was very uncertain that a further appropriation would be made by the Legislature, I directed the three corps of engineers, under my charge, to commence their operations on the *Middle* Route, as that route was undoubtedly the shortest, and I was desirous to lay before your Board, at least one continuous line from Harrisburg to Pittsburg. As soon as it was known that a further appropriation was made for the prosecution of the survey, I removed two corps from the middle route, and placed one on the northern and one on southern route. This delay was caused by the time consumed by one corps on the middle division, prevented me from pursuing the plan I had proposed of surveying the West Branch of the Susquehanna, from the mouth of the Bald Eagle creek to its sources in Indiana county, thence down the Two Lick and Black Lick creeks, to Blairsville, there to join the route already described to Pittsburg. I do not consider the northern route as being in a fair condition for comparison with the other routes until this portion is carefully surveyed, for it is well known that although the distance will be considerably increased over the route I have surveyed by the Clearfield, Chest creek and Black Lick, yet the summit is much lower, and the route will possess the advantage of less rise and fall, and lower gradients. The number of miles which remain to be surveyed from the mouth of the Bald Eagle creek, to join the surveys on the Black Lick, will not exceed one hundred and fifty miles.

On the southern route many surveys might be made connecting with the middle route, which would develope the resources of the country to a great extent, and the valuable and documentary evidence of the practicability of making railroads, which would prove profitable to a section of the State where so few public improvements have been made. My attention was directed by committees appointed at public meetings, to several routes which were recommended as possessing great advantages. My time was so constantly occupied in visiting the several corps engaged in field duty, and in reconnoisances upon the main lines, that I found it impossible personally to inspect all the routes recommended to my attention.

The following list exhibits the most prominent lines remaining yet to be surveyed, appertaining to the southern and middle routes;

From Petersburg on the Susquehanna at the mouth of Little Juniata creek, through Sherman's valley, passing the Tuscarora mountain, to the big Aughwick, and by that stream to the Juniata river. This route lies in Perry and Huntington counties, and the distance estimated as requisite to be surveyed, so that its practicability can be tested, is forty miles.

The next route is from Sideling Hill to the Juniata by way of the Big Aughwick creek; the line to be snrveyed lying altogether in Huntingdon county—distance to be surveyed estimated at twenty miles.

A route is proposed from Bedford to Johnstown, by Stony creek, passing through Bedford, Somerset and Cambria counties—distance to be surveyed estimated at fifty miles.

A route between Bedford and Cumberland, to connect with the Baltimore and Ohio Railroad, by way of Buffalo creek, was strongly recommended to be surveyed—this distance will be forty miles.

The survey for a route between Somerset and the junction of Jacobs creek with the Youghiogheny, connecting with Pittsburg by the line located for the Baltimore and Ohio railroad, has been estimated at sixty miles.

The survey for the line from Ligonier to Johnstown was commenced, and fifteen miles instrumentally examined during the past season. The necessity of finishing the continuous line on the middle route from Petersburg on the Juniata river, to Huntingdon, compelled me to relinquish the survey until more time was allowed for its prosecution. Fifteen miles is the distance estimated to complete the connection between Ligonier and Johnstown.

On the middle route there remains about seventy miles to be surveyed for the purpose of ascertaining, if it be practicable, to shorten the line in a few places. The route by which the greatest distance may be saved, is proposed to be surveyed from Petersburg, near the mouth of the Little Juniata, Huntingdon county, to Lewistown, Mifflin county, by the way of Sharer's run, Belleville and the Kishacoquillas valley. If this route should be found, upon examination, to present favorable features, a distance of ten miles may be cut off from the middle route, and the whole distance from Philadelphia to Pittsburg reduced to three hundred and thirty-eight miles.

On the northern route many lines have to be instrumentally examined, the most important of which is that extending from the mouth of the Bald Eagle creek, Clinton county, up the west branch of the Susquehanna to its source in Indiana county, and thence by the Two Lick creek to the line already surveyed on the Black Lick. By this line I feel now convinced that much lower gradients can be obtained than by the route I have examined, although the distance will be increased considerably; how much I am not now prepared to state, but the distance will, I think, be more than counterbalanced by the saving in rise and fall, and the obtaining of more favorable gradients.

In my report of last year I gave you a list of routes to be surveyed, and have thus described the Bald Eagle and Nittany valley routes, projected to save distance :—"It leaves the Susquehanna at the mouth of White Deer creek, in Union county, and proceeding up the valley of this stream, passes through the Nittany mountain, at the T spring, head of Big Fishing creek, thence descending on the slopes of the Nittany mountain and by the ridge skirting Little Fishing creek, to the table land of Nittany valley, thence through the Spring creek gap in the Muncy mountain to the valley of the Bald Eagle creek, where the line will unite with the route already surveyed at or near Milesburg"—distance estimated to be surveyed is forty-five miles.

The Penn's creek route is also described, in the report above alluded to, as leaving the Susquehanna at Selinsgrove, in Union county, and following the valley in Penn's creek, passes through the highly cultivated region on its borders, and by the town of Earlysburg, Bolesburg, Pinegrove, Gatesburg and Warrior's Mark, to the junction of the Little Bald Eagle and the Little Juniata—

thence by the valley of the first named stream to the vicinity of Hanna's furnace, where it unites with the route already surveyed. This route has the advantage over the route by the West Branch and Bald Eagle, it being about twenty-five miles shorter—distance estimated to be surveyed is ninety miles.

The whole distance remaining to be surveyed, to establish the routes as far as ascertained, is five hundred and sixty miles.

The above enumerated routes proposed for examination pertain to the line of survey for a continuous railroad from Harrisburg to Pittsburg. I would wish most earnestly to call the attention of the Board, also to the necessity of ascertaining the practicability of constructing a railroad from a point on the proposed line of railroad from Harrisburg to Pittsburg, on the Conemaugh at or near Blairsville, to Erie, on lake Erie.

Previous to entering upon a detailed description of the routes, I would wish to express the entire satisfaction I feel in the manner in which the several surveys have been conducted by my principal assistants, Messrs. J. C. Stocker, S. M. Fox, and J. A. Roebling, and the corps under their immediate charge. Living almost entirely in tents, and traversing for the greater part of the time occupied by the survey, the wildest portions of our State, they pursued their laborious occupation with a steadiness and perseverance which overcame every obstacle; and I am happy to state, that whenever an opportunity has offered for testing the work done, (and these opportunities have occurred more frequently on this than upon any survey upon which I have been engaged,) the accuracy with which the levels and the compass lines have joined, prove the care and skill shown by the parties employed on the survey.

* * * * * *

The route for a continuous railroad which will connect Harrisburg with Pittsburg by the shortest distance, and with the least expense, has been found to be that already noticed as the middle route.

The results of the surveys on this route have proved so much more favorable than I had any reason to expect, that I am induced to give to your board a more detailed description than I had intended in this report. The importance of the discovery of a line of railroad from the canal at Huntingdon, in Huntingdon county, to Johnstown, in Cambria county, by which *all the inclined planes* on the Portage railroad can be avoided, with an increase of distance of *only four miles* over the route by the canal and Portage railroad (without any inclination exceeding *forty-five feet per mile,*) also induces me to enter more minutely into the details of the surveys than this report would otherwise warrant; as I had intended only giving a general description of the manner in which the surveys had been conducted, with their results, leaving for my last report, when the estimates, maps, profiles, &c., should be delivered to your board, and all the details of the line surveyed.

* * * * * *

The report next proceeds to describe the Conemaugh route, by which the inclined planes on the western side of the mountain can be avoided, and the distance from the summit of the Allegany to Johnstown increased but one mile, which we are obliged to omit, with the exception of the following paragraph:—

An important discovery has been made connected with this portion of the Conemaugh route, and independent of its interest to the general survey. It is that three of the inclined planes at present used on the western side of the mountain can be avoided. Our line at the foot of Plane No. 4, is only twenty feet below it, and the ground is gently sloping; a connection between the plane and the new survey could be made at this point in a distance of six hundred feet. From thence to Johnstown, a distance of 21.50 miles, by making only twelve miles of new road, over ground of very favorable character, at a grade of 44.88 feet per mile, the Plane Nos. 1, 2 and 3, could be dispensed with.

The following Table exhibits the rise and fall, distance, and highest gradient upon the three grand routes surveyed between Harrisburg and Pittsburg.

Names of Routes.		Rise in feet.	Fall in feet.	Distance in miles and decimals.	Highest gradients in feet per mile.
Northern Route,		2840.51	2408 51	320.61	45.00
Southern Route,	Hage's Line of 1838,	5254.00	4825.00	294.42	60.00
	Line surveyed in 1839, and 1840,	5073.00	4671.00	274.50	110.00
Middle Route,	By the Conemaugh,	2742.06	2301.02	248.64	45.00
	By the Black Lick,	2807.53	2375.50	242.86	45.00

PRELIMINARY REPORT ON THE SURVEY FOR A M'ADAMIZED ROAD FROM LAUGHLINSTOWN TO CHAMBERSBURGH.

The great importance attached to this road induced me to direct Mr. Roebling, (the principal assistant detailed for this duty,) to conduct the survey in precisely the same manner in which our railroad surveys had been made, and to establish a regular system of gradients, in no instance, if practicable, to exceed an inclination of two and a-half degrees, or two hundred and thirty feet per mile. It was expected that a road passing over the Laurel hill, Allegany mountain, Ray's hill, Sideling hill, Scrub and Cove mountains, with such light gradients, would naturally exceed in distance the old turnpike, which is carried over the mountains with inclinations of four and a half and five degrees. The increase of distance, however, has fallen far below our first calculations, as by the line located, this increase is found to be only eleven miles.

From the great care with which the lines have been surveyed, it is believed that the best route for a M'Adamized road between Laughlinstown and Loudon has been traced. The interest of the towns and villages along the old turnpike may operate in some instances to change the direction of the line surveyed, but as no intermediate points were fixed by the act authorising the survey, the route was chosen which was the best and most direct, without any reference whatever to the old turnpike.

In my final report it is my intention to notice at length where the road may deviate from its located course, in order that it may pass through the towns and villages on the old turnpike. The maps which will be handed to your board, with that report, will show the course of the old turnpike and the projected M'Adamized road, together with all the proposed intersections and points of divergence.

The surveys this year commenced on the summit of Laurel hill, as a line for a M'Adamized road from Laughlinstown to the summit, had been surveyed the previous year whilst tracing experimental lines for the railroad.

The line crosses the old turnpike at the summit of Laurel hill, and turning south, does not again touch it until it arrives at the summit of the Allegany mountain.

The peculiar features of Somerset county, which have directed the general course of the route lying between the two mountains, and of which I shall take an opportunity of describing more in detail in my final report, caused the general course of the line to pass nearly parallel with the old turnpike at a distance of about two miles.

Mr. Roebling thus describes the surveys in his communication to me last October:

Our line descends the eastern slope of the Laurel hill with the maxium grade of two and a-half degrees, (or two hundred and thirty feet per mile,) and heads some branches of the beaver dam run which forms a branch of the Quemahoning. The same valley conducts the line to the forks of the Quemahoning. Thence a ridge is passed which divides the waters of the Quemahoning from those of Stoney creek. A small branch of Stoney creek, also named Beaver run, forms a valley by which our line continues several miles to a neck of high table land, included by the fork which the Beaver run and Stoney creek form above Stoystown. This high flat is crossed in a favorable manner, and the passage of the Stoney creek effected near the mouth of Mastaller's run. Leaving Stoney creek and ascending one of its branches, the Laurel run, we pass over a summit and descend to Clear run, another branch of Stoney creek. The valley of Clear run then offered the best opportunity of attaining the summit of the Allegany mountain in a course nearly straight and with no grade exceeding two and a half degrees, without losing any distance in consequence of grading.

The summit of the Allegany is passed about one and a-half miles south of the present turnpike. The line then descending with the maximum grade, intersects the old turnpike at the head of the Breastwork run. Thence the old turnpike is left to the right, and the new line, taking advantage of the mountain slope, descends two and a-half degrees to the foot of the mountain. The valley was then followed to Bedford, in order to avoid the Chesnut ridge and Mill ridge near Schellsburg. From Bedford, the valley of the Raystown Branch of the Juniata is pursued along the old turnpike to the Crossing. Here a deviation from the course of the old turn pike became again necessary, to enable us to ascend Ray's hill without losing distance. This has been effected in a very easy manner by turning up the main draft of that ravine by which the turnpike is located.

To convey a correct idea of the location of the line over Sideling hill, and that most difficult ground to Scrub mountain and Scrub ridge, would require a more minute description than would be necessary in this report. Suffice it here to remark, that the whole extent of country from the Juniata to Cove mountain, where most difficulties are united, has been so thoroughly examined, that I believe no better line can be found than the one actually surveyed. We have obtained favorable lines and grades without any material increase of distance over the present turnpike.

The greatest obstacle on the whole route is Cove mountain, particularly the eastern descent which amounts to fifteen hundred feet. The western ascent has been effected without much difficulty, but not so the eastern slope, down which the line was graded six and a half miles, in order to overcome the fall.

The line terminates at Loudon, at the eastern base of Cove mountain. The whole distance from Laughlinstown is ninety-eight miles. The present turnpike measured eighty-seven miles, therefore eleven miles less. This increase of distance on the new line is altogether owing to the reduction of grades in passing the mountains. Between the mountains we have generally saved distance.

In comparing the two lines, we should chiefly fix our attention upon the gradients. There will be a *virtual* saving of distance in the new line of at least one-third for heavy wagoning, and of one-fifth to a four*th* for light conveyances. A light carriage will traverse the new line from Laughlinstown to Loudon conveniently in twenty hours running time, provided the road is kept in good order. The old turnpike requires at the least thirty hours. Well organized stages may run the whole distance from Laughlinstown to Loudon in twelve hours with certainty, and without working the horses harder than they are worked on the present turnpike. But the great difference in favor of the new route becomes fully apparent, when we consider the increase of load the wagons will be capable of hauling upon the new line. The heaviest load a good six horse team can haul over the present turnpike is seventy-five hundred weight. Intelligent wagoners with whom I have conversed on this subject, have assured me that they can load one-half more *at least* on a road with inclinations of two and a half degrees, and drive over in less time than they do on the present road.

The maps profiles, and estimates of all the routes surveyed are now rapidly progressing under my direction. The large map which was exhibited in the hall of the Legislature last year, and upon which the routes, as far as they were *then* surveyed were delineated, has been this year used from motives of economy to exhibit the routes surveyed during the past season. This map will be placed in its former position in a few days, when all the routes described in this report can be easily traced, and as the data upon which the map was formed, has been furnished from actual surveys made by engineers in the State service, it is believed that it will furnish more correct geographical information than any map which has been made of that portion of the State of Pennsylvania between the waters of the Susquehanna and the Ohio river.

Your obedient servant,

CHARLES L. SCHLATTER, *Chief Engineer.*

Harrisburg, Jan. 9, 1841.

APPENDIX.

The following list will exhibit the distances by railroads already made, in progress, and contemplated, between Cleveland and Erie (on Lake Erie,) and Boston, New York, Baltimore, and Philadelphia:

	Miles.	
From Boston to Albany, via the Boston and Worcester, and the Western railroad,	200	
" Albany to Buffalo,	318	
" Buffalo to Cleveland,	210	
" Boston to Cleveland,	——	728 miles.*
" New York to Buffalo by the Albany railr'd,	474	
" Buffalo to Cleveland,	210	
" New York to Cleveland,	——	684 miles.†
" Philadelphia to Cleveland by the Pennsylvania canals and railroads, via Pittsburg and Beaver to Erie, and from Erie by the lake to Cleveland,		682 miles.
" New York to Dunkirk by the New York and Erie railroad,	484	
" Dunkirk to Cleveland,	170	
" New York to Cleveland,	——	654 miles.‡
" New York to Philadelphia, via the New Jersey railroads,	85	
" Philadelphia to Cleveland by the railroads now in use, and by the projected railroads from Harrisburg to Pittsburg,	478	
" New York to Cleveland,	——	563 miles.‖
" Philadelphia to Pittsburg by the Philadelphia and Columbia railroad, and the Lan-		

* On the Western railroad the grades rise from sixty to eighty feet per mile.

† On this route the gradients rise as high as ninety feet per mile.

‡ on the New York and Erie railroad the gradients are sixty feet per mile in many places.

‖ On the railroad from Philadelphia to Pittsburg, it is now well ascertained that no gradient will exceed forty-five feet per mile, and the section of country lying between Pittsburg and Cleveland has been so thoroughly examined with a view to the formation of canals, that no doubt can exist of the practicability of making a railroad between the two points with still lower gradients than have been obtained between Pittsburg and Philadelphia.

	caster and Harrisburg railroad, and by the route as surveyed in 1839 and '40,	348	
"	Pittsburg to Cleveland,	130	
		——	478 miles.
"	Baltimore to Pittsburg by the Baltimore and Ohio railroad,	340	
"	Pittsburg to Cleveland,	——	470 miles.*
"	From Philadelphia to Erie, via Reading, Little Schuylkill, Catawissa, and Sunbury and Erie railroads to Erie; Lake to Erie, as reported by Edward Miller, Esq., C. E.		555 miles.

ROUTES TO ERIE.

"	Philadelphia to Blairsville by the Middle Route,	306	
"	Blairsville to Freeport,	42	
"	Freeport by Buffalo creek, via Meadville, to Erie, estimated at	130	
"	Philadelphia to Erie,	——	478 miles.

If the above route should not prove practicable, no doubts can be entertained that the line of railroad could be carried by the canal route surveyed in 1826, by the engineers employed in the State service, from the mouth of the Kiskiminetas to Waterford, by the Allegany river and French creek. From Waterford a line has been located for the Sunbury and Erie railroad by Mr. Miller. By this route I estimate the distance from Philadelphia to Erie at 490 miles.

It will be perceived from the foregoing statements that Philadelphia has the advantage in distance over the city of New York by the nearest routes from Cleveland, passing through the respective States in which those cities are situated, of 166 miles.

The advantage over Boston in point of distance is 250 miles.

Baltimore is eight miles nearer than Philadelphia to Cleveland, by the Baltimore and Ohio railroad, but the advantage in gradients is decidedly in favor of the route to Philadelphia, through Ohio and Pennsylvania.

DEATH OF CLYNTHUS GREGORY, L. L. D. We omitted mentioning in our last, the decease of this distinguished man, in the 67th year of his age. The labors of Dr. Gregory have all been of a practical character, and have given him a high reputation.

ERRATA.—In the No. for March 15th, page 164, 8th line from top, insert *Menai Bridge,* in place of " Vienna Bridge. On the same page, 14th line from top, read 32,000, *Thirty-two thourand,* in place of " 52,000."

* Upon the Baltimore and Ohio railroad the gradients at two points exceed eighty feet per mile, and for over thirty miles are as high as sixty feet per mile.

THIRTEENTH ANNUAL REPORT OF THE PRESIDENT AND DIRECTORS TO THE STOCKHOLDERS OF THE BALTIMORE AND SUSQUEHANNA RAILROAD COMPANY. (December 15th., 1840.

The president and directors of the Baltimore and Susquehanna Railroad Company, submit to the stockholders a report of their proceedings during the year, ending on the 30th September, 1840.

Our last annual report apprized the Stockholders of the difficulties which had rendered the act of Assembly of December session, 1838, chap. 395, unavailable for the relief of the company. By the provisions of that act, a loan of seven hundred and fifty thousand dollars, was to be made by the State, to the company, for the purpose of enabling us to complete both our own works, and a portion of the Wrightsville, York and Gettysburg Railroad; but when the act had beeh accepted by the company, notwithstanding the objections which many of the stockholders entertained to its provisions, it was found that one of its restrictions, prohibiting a sale of the State five per cent. stock for a less price than its nominal par value, deprived the company of the benefits which it was the object of the act to afford, as the commissioner of loans was unable to effect sales of the stock to any great extent at that rate. Application was made to the legislature at their last session to remove this restriction; and in pursuance of the resolutions adopted by the stockholders in general meeting, on the 4th June, 1838, the memorial presented by the board, likewise represented the views entertained of other provisions of the act by the individual stockholders in the company, and solicited a modification of them. By the act of December session, 1839, chap. 20, the legislature authorised a six per cent. stock, to be issued in lieu of the five per cent. stock; but no other change in the features of the law could be obtained. The same limitation, however, on the sale of the new stock was again prescribed, and the stocks of the State having all been throughout the year somewhat below par, the commissioner of loans has only been able to dispose of the stock issued for this company, by receiving in payment for it the claims of such of the creditors of the company as were willing to purchase the stock at par to the amount of their respective claims. This, however, has been done to so great an extent, that the debts of the company, except those for interest due the State and city, have been reduced to a comparatively small amount; and to meet them, the stock still remains in the hands of the commissioner. The act last mentioned, also reserved out of the stock to be issued, an amount equal to the interest due by the company to the State, to the 1st of January, 1840.

In the month of April last, the long sought communication with the Pennsylvania improvements, by an unbroken line of railroad from Baltimore to Columbia was at length obtained; by the completion of that portion of the road of the Wrightsville, York and Gettysburg Railroad Company, which extends from York to Wrightsville. By agreement between that company and this, the locomotives of the Baltimore and Susquehanna Railroad Company run to Wrightsville; and hitherto the whole transportation on the road has been done by them. To the trade of Baltimore the same facilities are thus given as if this company had succeeded in directly carrying into effect their original design, of constructing, under the authority of the single charter, a railroad "from the city of Baltimore to some suitable point or points on the Susquehanna River." We have, therefore, now to congratulate the stockholders on their having practically completed the enterprise in which they so zealously engaged, and in which they have persevered through difficulties and embarrassments, such as it has been the lot of but few similar companies to encounter, and perhaps of still fewer to surmount.

Soon after the communication with the Pennsylvania canals, and the Columbia Railroad was thus opened, the transportation line of Messrs. D. Leech & Co., established a depot in Howard street, and made arrangements for running their cars regularly on tho road, carrying produce and merchandise between Baltimore and Pittsburg, or other points on the line of the Pennsylvania works. At a later period Messrs. Bingham & Brothers opened a depot in the same neighborhood, and placed their line on the road. During the fall the proprietors of the Portable Boat Line also made preparations to use this route; but no cars of this line have yet run on the road, though some freight has been forwarded by its agents. Besides these lines, Messrs. Jas. O'Conner & Co., whose portable Car Body Line commenced business on the road as soon as it was completed to York, as mentioned in our last annual report, have kept their line regularly in operation throughout the season, running from their depot in North street. The Emigrant Line of Leech & Co., has continued to forward that class of passengers for Pittsburg to Wrightsville, in the cars of the company.

The whole amount of transportation over the road by the three lines of Messrs. O'Conner, Leech and Bingham, from the 1st October, 1839, to the 1st October, 1840, has been,

Transported Eastward,	7,078,734 lbs.,	equal to	$3,539\frac{734}{2000}$ tons.
Transported Westward,	6,329,662 lbs.,	equal to	$3,164\frac{1662}{2000}$ tons.
Total,	13,708,396 lbs.,	-	$6,854\frac{396}{2000}$ tons.

This trade was all carried on with places beyond Columbia, and nearly, if not quite the whole of it, with Pittsburg.

In addition to the regular transportation lines, the plan adopted by the company, of permitting cars, owned by individuals, to pass over the road, paying a certain rate for toll, and for the motive power furnished by the company, has had the effect of bringing trade on the road, which otherwise would probably not have sought this market. This being the system pursued exclusively on the Philadelphia and Columbia Railroad. Many persons who have occasion to transport extensively on that road, are provided with their own cars, and these being loaded with produce, its owners have now the option of sending them either to Philadelphia or Baltimore. Within the last few months, not only have cars reached Baltimore from places situated on the State road, at a considerable distance beyond Columbia, but others have made repeated trips to this city from the Harrisburg Railroad, and from Carlisle and Chambersburg. The route taken by the latter is by the Cumberland Valley railroad, which extends from Chambersburg to Harrisburg, by the Harrisburg, Portsmouth, Mount Joy, and Lancaster railroad, and the Philadelphia and Columbia railroad. This trade has but lately commenced, but seems likely soon to become of an important magnitude.

The Revenue of the Transportation Department, from 1*st October*, 1839, *to the* 30*th September*, 1840, *has been, from*

Passengers, 36,162,	$45,561 23
Merchandize, 62,097,089 lbs.,	74,225 98
United States Mail,	8,065 05
	$127,852 26

Of which collected from Passengers and Merchandize,		$118,152 14	
United States Mail,		5,876 30	
		$124,028 44	
Less amount outstanding, last report,		6,329 89	117,698 55
Outstanding, 30th September, 1840,			$10,153 71
Being for Merchandize,		$7,614 96	
United States Mail,		2,538 75	
		$10,153 71	
Total amount of Transportation,			$127,852 26
The expenses paid on account of Transportation for same period, have been		$92,273 32	
Less debts of last year paid,		8,757 88	
		$83,515 44	
Debts outstanding,	$5,372 39		
Less value materials,	3,439 87	1,932 52	85,447 96
			$42,404 30
Office expenses for the same period,			5,316 27
			$37,088 03
To which add two-thirds of the gross receipts on the W. Y. & G. railroad, for the estimated proportion of this Company, $10,862 91,			7,241 94
Nett,			$44,329 97

It will be seen that we add to the nett receipts of the company, our estimated proportion of the revenue received for transportation on the Wrightsville road. Our locomotives exclusively, have run over the road, and we have received all the revenue, charging generally about the same rates as between this and York. We are from this revenue to pay the Wrightsville Company for tolls for the use of the road, the same tolls which were in 1838 charged on the Philadelphia and Columbia railroad. The accounts between the two companies being not yet settled, we can only give an estimate of our proportion, which, however, we believe will be found to be less than the amount which we will be actually entitled to retain. The amount which has actually been paid to that company on this account. is $2,120 45. In the above statement of expenditures by the transportation department, are included all our expenses of transportation on the Wrightsville road.

From the foregoing statement it will be perceived, that, although there has been a considerable increase in the revenue of the company, as compared with the preceding year, it has not yet reached the amount which has been anticipated, and which must be realized before the company will be in a condition to discharge the annual demands of the State and of the City, for interest on their respective loans. That this has been the case, is the source of much regret, but we trust that the prominent causes which have operated to produce this result, will prove to be but temporary in their character, and the company will yet, ere long, be found in a position to meet all the engagements of every description, which it has assumed. It will be remembered that almost simultaneously with the completion of the railroad to Wrightsville, was opened another communication between the city of Baltimore and the same point, by the Tide Water and Susquehanna canals. Although these works may have brought to the city, trade that would not otherwise have reached it, they have also had the effect, during the past summer, of diverting a part of that which would have passed over the Baltimore and Susquehanna railroad. In what degree the business of the railroad has been thereby lessened, we cannot say, but it must have been so to a considerable extent. But at the same time it may be doubted whether the effects of the construction of these canals will be permanently injurious to the interest of the railroad. The amount of trade which will be drawn to this city by the facilities offered by both lines of communication for its transit, may reasonably be expected to become much greater than Baltimore has heretofore enjoyed, and perhaps will be more than either line singly would have attracted. Of this new trade the road will have its full share and it may well happen, that both the canals and railroad will shortly be more fully employed than either would have been, had but the one route existed. These works having all been completed to Columbia last spring, cannot be supposd yet to have developed the results which they will produce; while by dividing the trade which was already prepared to avail itself of the advantages of these new routes, they have for the present, each rendered the other the less productive. It will be admitted too, that the trade from the city to the interior, which pays the highest rate of toll and freight, has not, during the past year, been by any means, so great as may be calculated on in periods of ordinary activity and freedom from commercial embarrassments. We believe, therefore, that it is reasonable to expect that the future revenue of the company will be found constantly to increase, and that even during the next year, it will greatly exceed that of the past.

The whole amount earned by the transportation department, beyond its expenses, we have not been able to make available towards the payment of interest to the State. Several parties who made use of the road for the transportation of produce and merchandize, (some of them to a great extent) were creditors of the company, and declining to purchase the State stock in satisfaction of their claims, the company were compelled to receive a large amount of their own obligations in payments for freight. Again, in repeated instances, in consequence of the disappointment of the creditors, by the inability of the company to meet their demands as was anticipated when the law of 1838 was passed, suits had been brought, and judgments obtained against the company, and the whole operations of the road were in danger of being interrupted by levies upon the property of the company, and suspended for an indefinite period, until the termination of an expensive court of litigation. Several claims of this character the company have had to extinguish during the year, and their only means of doing so was by the temporary appropriation to that object, of a portion of the funds derived from the revenue. It is not deemed necessary in this report, to enter more particularly into a detail of these circumstances, however embarrassing they have been to the operations of the company. We can, however, with confidence express our conviction, that in all the measures we have pursued, the true interests of the company have been consulted, and we feel assured that should a more particular statement of our proceedings be called for, either by the stockholders, or by the authority of any other party, having the right to make such inquiry, we shall be found to have discharged, with a proper regard to the interests entrusted to our care, the duties which devolved upon us.

On the Westminister branch, passenger cars have run to Owings' Mills throughout the season, but are withdrawn in the winter, as locomotives cannot be used on that track, and it could not consequently be kept clear of snow, except at an expense which we would not be justified in incurring. The time limited by law for the completion of the road to Westminister will shortly expire, and an application to the legislature, to extend the period will be necessary.

We have much pleasure in stating that the whole track of the road, from Baltimore to York, is now in perfect order; that part which at the date of our last report, was constructed with the plate rail, having since been entirely renewed with a heavy T rail, laid in a substantial and permanent manner. If the means of the company would justify a further expenditure in obtaining a passenger depot, within the city, and in improving their present depots by additional buildings, the comfort of passengers, and the facility of the company for carrying on its business, would be promoted; but without this, the company are now prepared to forward a much more extensive trade than has yet offered, and we do not therefore contemplate that any further expenditures will soon be required for those purposes. The soundness of the policy of constructing a railroad in a solid manner, with heavy rails, has received further proof by the experience of the year, in the small amonnt which has been required to keep the track in repair. This has cost for the twelve months, $10,378 35 for the whole distance of fifty-six miles; or on the average of $142 40 for each mile of heavy T rail, and $543 06 for each mile of the old plate rail track, which, until the month of August last, was the only one used for a distance of nearly six miles.

An unforeseen expenditure has been necessarily incurred this year, for arching a part of the tunnel on the York and Maryland line road, about five miles from York. Although this tunnel in its whole extent, passes through a rock, apparently solid, it was found that the operation of the frost at both ends of it, had last spring displaced several pieces of the rock, which fell on the track, and it was evident that the evil would continue to increase with each successive winter. To guard against a danger of so serious a character, strong arches have been constructed, extending at the northern opening of the tunnel, one hundred feet, and at the southern, thirty-two feet. The final returns of the cost of this necessary work have not yet been received, but it will be about six thousand dollars.

In the department of machinery, several improvements have been introduced, calculated to diminish materially the heavy annual cost of repairs. The principal of these consists in the substitution of cast iron wheels, with chilled tread, on the locomotives, for those with wrought iron tires which were before used; and which were found to wear so rapidly as to require frequent renewal, at a heavy expense. Chilled driving wheels of four and one half feet diameter have now been running on the road for six months, and have been found to answer perfectly; and from the success which has attended the experiment, other railroad companies, in different parts of tne country, have been induced to adopt the same improvement.

The regularity with which both the passenger and burthen trains have performed their trips since they first commenced running to York, has been such as to do the company much credit. On the occurrence of the extraordinary fall of snow in December, 1839, they were interrupted, as it is believed, were those on every road without exception, to which the storm extended. On the 1st of January last the company commenced carrying the mail, and from that day to the present, not a single trip has been lost, and but in a very few instances, have the passenger cars been so detained by any cause whatever, as to fail to deliver the mail before the contract time. The snow storm on the 4th, 5th and 6th inst., was one of unusual severity; but the trains both from Baltimore and York were only detained by it for a few hours on the 6th; the trips on every day but that being made with punctuality. The snow was cleared away without the employment of any additional force, or any extra expense, except that for the fuel and oil used by the locomotives required to drive the snow ploughs.

The annexed financial statement will show the total receipts and disbursements of the company to the 1st of October, 1840.

By order of the Board,

CHARLES HOWARD, *President.*

A condensed financial statement of the Baltimore & Susquehanna Railroad Company, to 30th September, 1840.

RECEIPTS:

From Capital Stock,	$450,000 00	
From Loans of State of Maryland,*	1,829,379 55	
From Loans of City of Baltimore,	850,000 00	
From nett transportation received from Balt. and Susq. and York and Md. Line Railroad Co.'s	60,005 19	
From gross transportation on Wrightsville, York and Gettysburg Railroad; less amount paid that company on account,	8,742 46	—$3,198,127 20

EXPENDITURES:

For Old Road,	$398,160 11	
For Stock York & Md. Line Railroad Co.	199,265 00	
For Construction do do	326,563 72	
For Graduat'n, Masonry & Construction,	631,328 49	
For Damages,	16,787, 92	
For Bridges,	115,797 96	
For Rail laying,	528,127 21	
For Timonium Division,	224,528 83	
For City Division,	59,877 01	
For Water Stations,	3,855 66	
For Office Expenses to Sep. 30,1839,	6,948 34	
For Salaries Pres't and Sec'ry do	9,491 30	
For Printing and Advertising, do	1,439 28	
For Legal advice,	6,312 45	
For Depots and Real Estate,	52,151 49	
For Locomotives,	106,920 04	
For Passenger and Burthen Cars,	77,628 55	
For Stock Wrightsville, York & Gettysburg Railroad Company,	120,150 00	
For Interest to State,	107,260 56	
For Interest to City,	57,500 00	
For Discount,	41,226 37	
For Loss on Sales City Stock,	18,421 72	
		3.109,742 01
Excess of Receipts,		$88,385 19

FUNDS AVAILABLE:

Cash and Agents,	$5,110 39
Bank Stocks,	3,436 43

UNAVAILABLE:

Bills Receivable and Balt. and Susquehanna Railroad Stock,	29,015 31
Wrightsville, York & Gettysburg Railroad Company,	102,562 89
	$140,125 02

DEBTS:

Sundry Credits on Books,	$4,471 03		
Bills Payable,	31,439 08		
Company $100 notes,	15,300 00		
Company $5 and 10 notes,	20 00		
Company $1 and 2 notes,	509 00		
		$51,739 83	$88,385 19

ROB. S. HOLLINS, *Secretary.*

*REMARKS:

Of the Loan from the State, chap. 395, 1838, *there has been issued to the 1st October,* 1840.

Of the 5 per cent. stock,	$88,710 97	
Of the 6 per cent. stock,	488,668 58	
		$577,379 55
Due to the State for interest to Jany. 1st, 1840, which is to be taken in stock,		112,500 00
Leaving yet to be disposed of, for the uses of the Company,		60,120 45
		$750,000 00

The practical character of Armstrong's work on steam boilers, has induced us frequently to refer to it. There is one portion, however, which is if possible of more utility than the rest, viz. that which refers to "priming," foul boilers, and sediment. Few works have treated so largely upon these points, and being at the bottom of more mischief than is usually suspected, these accidents or defects deserve more attention from Engineers than they have hitherto received. We shall therefore endeavor to select such portions of the work, as are most valuable upon this topic, and produce them for the benefit of our readers.

CAUSE AND EFFECTS OF PRIMING.

If a boiler were only required to generate a certain quantity of steam, and that always at an uniform rate, it would only be necessary to supply it uniformly with water, and by applying a regular heat, the desired result would be attained; but the case is very different to this in practice. From the necessarily intermittent action of the valves of all steam engines, the supply of steam being momentarily cut off at each stroke, as well as for a considerable period during each stroke in those engines that work expansively, the effect is to throw the water of the boiler into an undulatory motion, as may at any time be perceived by observing its effect in the glass tube of the water gauge* now so generally attached to boilers.

This undulatory action of which we speak, is apparently independent of or at least in addition to, the intermittent state of alternate ebullition and repose before described. At any rate, from one of these conditions, or from both combined, it is certain that the agitation of the water occasionally becomes so violent as to cause the latter to follow the steam into the cylinder and when in too great a quantity to escape through the steam port in the return stroke, it infallibly breaks down the engine.

We speak of the effect thus positively as regards factory engines, because they are not, and cannot be expected to be, calculated to withstand a sudden blow, and such it is in reality. For if the water primes into the cylinder in sufficient quantity in the down stroke, it must remain on the top of the piston until it strikes against the cylinder cover in the up stroke, with more or less violence according to quantity. From the incompressibility of water, of course the effect is the same as if a piece of iron of equal thickness to the depth of water was suddenly inserted in its place. The tremendous effect sometimes produced when a large engine of 80 or 100 horse power breaks down from this cause, is a matter of notoriety in Manchester; for as the vacant space left at the top of the cylinder is generally of no greater depth in large than in small engines, the intruding body of water strikes the cylinder cover with a proportionally greater force. Generally the accident does not end with merely straining or breaking the crank pin, as is frequently the extent of the injury in small engines; but the momentum of the beam is then added to that of the fly wheel, and their combined force is exerted directly in splitting the cylinder, or tearing off the cylinder cover, thence effectually demolishing all the rods and gearing, in fact the main beam itself also sometimes gives way, leaving almost nothing whole except the fly wheel.

In analyzing the various causes concerned in the production of the effects above described, we must not overlook the fact that the tendency of the water to rise into the cylinder is always considerably promoted by the very usual situation of the steam or induction pipe at the back end of the boiler; this seems to arise partly from the constant circulation of the water, which causes a current at the surface, to set in the direction of the length of the boiler from the front end to the back.

This circulation of the water in a steam engine boiler, of course, takes place in all boilers, with a certain velocity depending upon the ratio that the intensity of the heat in the furnace bears to the quantity of water to be kept heated; and it is entirely independent of the other two causes before stated, but it is most probable that all three are combined in producing waves which take their rise over the fire and gradually increase in height as they pass towards the back part of the boiler; for it is a fact, although not generally known, even to workmen, that the water line or mark which is left by the surface of the water on the inside of the boiler is not level, but higher at the back end than the front, modified in some degree by the situation of the steam pipe.

* The *glass tube water gauge* is an appendage to boilers of so much use in testing the evaporating powers of different boilers, and in ascertaining the value of different kinds of fuel, or the merits of the various modes of firing, that it is a matter of astonishment how it is overlooked by any one; moreover, it is so well calculated to prevent accidents from a deficiency of water, that it cannot be too strongly recommended to all owners of high pressure engines.

The peculiar tendency of the water in a steam engine boiler, to rise into the cylinder, of which we have been treating, is well known to all experienced operative engineers, under the name of "priming," "flushing," "pumping," and other similar terms, but it has not been much adverted to by theoretical writers, nor is it yet looked to by steam engine and boiler makers with that attention which its importance deserves, although it is well known to most of them to be the principal if not the only thing which renders a large steam chamber necessary.

It is remarkable that when the inside of a boiler is examined immediately after the engine has primed much, marks are frequently found running in a slanting direction up the sides of the steam chamber towards the steam pipe, in nearly a direct line leading from that part of the surface of the water which is immediately over the hottest part of the furnace, just as if a partial explosion (if we may so call it) of the water had taken place in that part of the boiler and spent its main force in the direction stated. When there is any considerable quantity of mud or clay in the boiler, the marks indicating the direction of this explosion or flushing are particularly legible; and the effects of it, we have had many opportunities of observing in its forcible removal of heavy articles which had been placed in boilers for the purpose of preventing, if possible, the priming of the engine.

That waves are generated within the boiler when an engine is liable to prime, is a singular but well ascertained fact, as is shown by the frequent great and sudden depressions of the float at such times; especially if the latter happens to be placed at the contrary end of the boiler to that where the steam pipe is fixed. In watching the rapidly successive alternate elevations and depressions of the indicator buoy or float of a boiler in this condition, the tendency to prime may frequently be observed to recur periodically after intervals of a certain number of strokes, provided that the state of the fire and the load on the engine continue perfectly uniform.

Since the publication of Mr. J. Scott Russell's curious researches on the generation of waves in canals, it has occurred to us that his theory might possibly be applied to the illustration of the above singular phenomenon; and that if so, it will no doubt be found that the depth and form of the water chamber will considerably influence the law which seems to govern the periodical recurrence of this flushing of the water in the boiler. Those who have leisure and inclination to pursue this subject will find it an interesting field of inquiry, and far from being one of mere barren curiosity only, inasmuch as a few well directed experiments may lead to results calculated to unravel some of the still mysterious causes connected with the explosions of steam boilers; than which, no subject is more deserving of the aid of the funds of the British Association for the advancement of science, on account of the immense importance to the interests of humanity which it involves; and we know of no one half so well calculated both by talent and experience to elucidate that very perplexing and difficult subject than the gentleman above mentioned.

Although digressing farther than was intended, it may in order to point out the intimate connection of the two subjects alluded to, be just stated, that, we have known an instance of a very large safety valve (5 to 6 inches diameter) belonging to a high pressure engine that was liable to prime, which would always on being suddenly opened, discharge nothing but water, (although the latter had not previously been higher than usual,) to the great risk of the boiler becoming short of water and thereby creating an explosion; a fact which shows the inutility of very large safety valves, instead of two or three small ones of the same united area.

Although there are many boilers working with Tredgold's proportion of steam room, and even with a much smaller proportion, all that we have been able to meet with belong to high pressure or non-condensing engines, or those in which the steam is very much throttled or wire-drawn: that is, the pressure is invariably a great deal higher in the boiler than in the cylinder, and in some cases nearly double, as the application of the Inditator* has invariably shown. Hence the uniform failure of all attempts to introduce high pressure engines for working the cotton mills in Lancashire, where examples of the low pressure, condensing, or Boulton and Watt engines, are so numerons as to be a ready test of their comparative economy.

From this cause mainly, we have the tampering with the safety valves, and, consequently, accidents continually occurring where high pressure engines are in use. In low pressure boilers, the method of meeting the difficulty of too small a steam chamber, by raising the pressure of the steam, is not practicable to any thing like the same extent, on account of the usual method of feeding the boiler with water by means of the ordinary feed pipe, which boils over when the steam is too high; but where it can be done at all it generally is. With marine boilers, which are supplied direct from the force pump, in the same manner as those of high pressure engines, it is practised to a considerable extent, and is in the highest degree reprehensible, considering the immense destruction of human life that has sometimes taken place by the bursting of the boilers of steam packets.

REPORT OF THE ENGINEER UPON THE SEVERAL DEFINITE LOCATIONS FOR THE HARTFORD, AND SPRINGFIELD RAILROAD:

HARTFORD, MARCH 2D, 1841.

GENTLEMEN:—In obedience to your directions I have surveyed and located four routes for your contemplated railroad, and approximately located two other entire lines, besides making preliminary surveys and examinations on several experimental lines and the different proposed terminations for your road to a great extent. After having made unremitted exertions since the commencement of this survey on the 18th of December last, it has been found impracticable to collect all of the necessary information in relation to the costs of lands and damage, or the great amount of local business upon the different routes, to enable you to select at this time that which shall subserve best the interests of the corporation and of the community at large; still I have the honor to present a mass of facts fully sufficient to settle the question of the great importance of this work, and of its entire practicability at a moderate expense within the present year.

1. THE EAST ROUTE.

This is indicated on the map by the most eastern full red line on the east side of the Connecticut river. It commences at a point on Front street in the north-eastern section of the city of Hartford; from thence it takes an easterly direction, crossing first the river above mentioned, then the extensive river flats on an embankment made of the average height of twelve feet in a direction transverse to the general direction of the stream at high water; then after cutting moderately into the table on which East Hartford

* The steam engine indicator, as improved and rendered extremely portable by Mr. Mc Naught, of Glasgow, is now well known in Lancashire; and it is really of so much use to the steam engine proprietor in enabling him to detect the effect of any alterations in the engine, as well as a good approximation to ascertaining the comparative load on engines doing a similar kind of work, that it is only surprising not to find it a permanent appendage to all engines.

is situated, it finds a position on the surface of the extensive East Hartford and East Windsor plains. From this point the line sweeps around to the north, after which it may be laid on an easy grade nearly straight for about sixteen miles, and until it arrives at the diverging point of two lines, situated as shown on the map three-fourths of a mile east of the manufactories at Thompsonville. The only variation made in the line from its direct course has been for the purpose of passing the Podunk and Scantic rivers at their least expensive crossings. From the diverging point above mentioned, the most eastern line, after encountering a succession of deep cuts and corresponding embankments, arrives east of the Longmeadow church, then turning on a radius of large dimensions, it lays its northern tangent nearly in the direction of the contemplated depot in the south part of Springfield; curving more westerly from this point it unites with the Western railroad without serious inconvenience to the valuable property in the vicinity of which it passes. This tangent just mentioned crosses the valley of Pecowsic brook at its most favorable point; still it is necessary, even on the maximum grade of thirty feet per mile, to cut into the northern edge of the plain bounding this valley, to the depth of fifty feet: a small portion of clay undoubtedly and perhaps quicksand will be encountered in this excavation. From the diverging point before mentioned, the most western route passes with easy curves on the table land that projects at an altitude of about forty feet from the west edge of the plain, which forms the eastern boundary of the low lands of Longmeadow; finally, after cutting its way through the projecting bluff at the mouth of Pecowsic brook, passing over the saw-mill on that stream, laying its embankments above and beyond the reach of the highest floods, it curves moderately, and unites with the line just described.

2. EAST ROUTE ON THE EAST BANK OF THE RIVER.

This line occupies the ground upon which Mr. Twining approximately located his eastern route with the exception of a portion of the line at Warehouse Point, where an improvement has been made by throwing it easterly upon higher ground. An inspection of the map will show that this line commences at a point on Front street in the city of Hartford, and that after passing easterly across the river and the low grounds west of East Hartford, it takes a direction northerly, coursing its way alternately along on the table land that projects at intervals from the adjoining plains and on the intervening low river meadows, until it arrives at the depot of the Western railroad in Springfield. A large proportion of the required embankment on this line must be made from the heterogeneous mass of materials composing the river meadow. This not only contains an uncertain amount of vegetable matter, but being formed from the alluvial deposites and sediment of the adjoining river, its gravity is specifically less than that of ordinary fine river sand. To ensure the requisite stability of the road-bed on this material, against the combined action of frost and the river floods, the embankments should have a width of not less than twenty feet at the graded surface, and the bed upon which the superstructure rests should be composed of fine sand or clean gravel, to the depth of two feet, and laid at least three feet above the highest known rise of the river; large spaces should also be passed over on trestle work, giving an opportunity for the water to rise without obstruction to the same height on both sides of the embankment. This line in passing around the bold bluff at the mouth of Pecowsic brook, makes an objectionable curve, and unavoidably encroaches on the Connecticut river, so as to render a heavy slope and protection wall necessary for about eight hundred feet in length. A better location for this part of the route would most probably be obtained by throwing the line at Thompsonville so far east as to pass with a moderate curve on the table land which forms the eastern boundary of the long meadows before described. This route may be characterized, however, as being in general very direct, curves moderate and the grades remarkably easy.

3. COMBINED EAST AND WEST ROUTE.

This is one of the routes described by Prof. Twining in his able report of the preliminary surveys. Here I may perhaps be allowed to remark that I have not been able to consult with Prof. Twining, the engineer whom you selected for one of my counsellors; this is a cause of regret; his loss has, however, been compensated in part by the valuable assistance that I have received from consultations with Mr. Anderson now on the Western Railroad, and who was an engineer on your previous surveys and locations. The line under consideration, contemplates leaving Hartford at any point which its citizens may hereafter select in the northern and eastern portion of the city; it connects conveniently, though rather expensively, with the Hartford and New Haven railroad depot: a glance at the large map will show the different lines that have been surveyed and made the basis of estimates for its several terminating points. On leaving the city, the line pursues a very direct and easy northerly course until it arrives at the foot of the falls on Connecticut river.

The location to this point has been much improved by throwing the whole line farther west, and on higher ground, thus placing it nearly beyond the reach of the floods of the adjoining river. Although the soil, to a considerable extent, is argillaceous and extremely retentive of moisture, yet this whole distance constitutes a very cheap grade and preparation of road-bed. On the map a diverging line is exhibited at Windsor, passing east of the main line and through nearly the centre of Broad street; this was located there at the request of its inhabitants, and although it will cost something more than the westerly route, yet as it will do less damage to that enterprising town, I recommend that it be substituted in place of the former location. Immediately north of Windsor street, the line must of necessity cross the valley of the Farmington river; this, though short, will unavoidably make an expensive embankment. The river itself will require a bridge of four hundred feet in length, the foundation of the abutments and piers must rest on piling prepared for its reception, at least five feet below the bed of the stream; the floor timbers of the bridge to be perfectly secure from the effects of ice in times of the highest freshet must have an elevation of thirty-five feet above average low water.

Further north this line crosses Connecticut river as indicated on the foot of the falls, and unites after making an embankment of considerable magnitude, with the east line on the east bank of the river before described. This place of crossing, when examined in all of its bearings, will be found, in my judgment, more favorable for the construction and permanent security of a railroad bridge than any other which can be selected between Hartford and Springfield. The curves though smaller than upon most other parts of the line are still moderate; the embankments are necessarily heavy and unfavorably placed in relation to the general direction of the river; still their bases are so high above the ordinary floods that they may be cheaply protected. The foundation for a bridge superstructure is a consideration of the greatest importance; when your works can be founded on the solid rock, you only require good materials, suitably put together, to make your construction as durable as the rocks themselves; in a work of this magnitude, when you have not such a foundation, you must make one that shall be equal to it. There has been such a constant passing of ice during the past mild winter, that it has not been possible to make the requisite soundings, to ascertain with certainty the exact character of the river bed at this desirable crossing; from the best knowledge that I can obtain, however, from those who are well acquainted with the river at this point, I am inclined to believe that a rock foundation exists at no inconvenient depth below the bed of the stream. If so, this will doubtless be a consideration of great weight in favor of the final location of this road upon this route.

4. WEST ROUTE ON THE WEST BANK OF THE RIVER.

This line from Hartford to the foot of the falls, forms the southern half of the combined east and west route just described. Commencing the description therefore at a point one quarter of a mile west and south of Abbe's tavern, the whole "approximately located" line, extending in a northerly direction nine miles, was thrown directly west so far as to pass entirely clear of nearly the whole of the deep basins and ravines in the immediate vicinity of the falls and canal, and crossing Stoney Brook at the only point where natural rock abutments can be obtained for the necessary bridge superstructure. This line as improved, is very direct, and instead of being onerously expensive, as was the case with the old line, it has a remarkably cheap and easy grade. A part of this great improvement was suggested by Mr. Twining in his report, the remaining portion is due to the engineer upon that line. (See detailed report marked A.) Several branch lines were run in this vicinity for various objects. On the line which crosses King's Island, it was necessary to adopt a grade of forty feet to the mile, thus exceeding the maximum grade established on every other line by ten feet per mile, besides giving an increased length of bridge superstructure compared with the crossing at the foot of the falls, of two hundred feet. On the line which crosses the river at the head of the falls, it is necessary to introduce curves that are considered objectionable; in all other respects this crossing is favorable, presenting a rock foundation for the bridge superstructure. From the State line northerly, the located route coincides with that formerly surveyed. Towards its termination, it diverges and crosses the Agawam river and valley in two distinct lines. In both cases the embankments are extremely heavy, and placed, particularly on the eastern line, in a direction transverse to the general current of the Agawam river, which is extremely rapid in time of high freshets. I am of the opinion, however, all things being duly considered, that the eastern line crossing directly the Agawam and its meadows are preferable to the one farther west, and have based my estimates accordingly.

(To be continued.)

Boston and Lowell Railroad.—From the last annual report we learn that four miles of second track have been laid during the last year making twenty miles of this track now in use, and leaving about five miles only to be laid, which will probably be completed in the course of the ensuing summer. The amount expended in construction to the present time is $1,729,242; leaving of the capital unexpended $70,557.

The receipts of the last year amounted to $231,575, of which from passengers in cars of the Boston and Lowell Railroad 85,928; merchandise in do 80,328, mail 1,958; from the Nashua and Lowell Railroads 24,347; merchandise from do. 18,928; passengers from Boston and Portland Railroad 16,733; merchandize do. $4,358.

The expense of the year were for repairs of road $21,813; repairs of engines and cars, 12,465; other expenses 55,933; total $91,400. Two dividends have been paid during the year, of 4 per cent, each; on $1,650,000, amounting to $132,000.

AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 10, Vol. VI. New Series. | MAY 15, 1841. | Whole No. 382. Vol. XII.

RETARDING EFFECT OF MOISTURE, DUST, ETC., UPON RAILROAD TRAINS.

The general principle, that all foreign substances interposed between the wheels of a train of cars and the rails, diminish the velocity, by an increase of resistance, has long been established. The component effect resulting from the opposite action of such substances upon the drivers and running wheels, has not however been made, as far as we are aware, the subject of exact experiment, and yet no mere accidental circumstance has more influence than what is commonly referred to as the "state of the rails." It no doubt has frequently occurred to those of the profession who have reflected upon this subject, that beneficial results would follow an investigation into the law and causes of the state of surface of rails and wheels. At the risk of appearing tedious upon so simple a matter, we will endeavor to recapitulate the data upon which such investigations must be founded.

The whole theory of locomotion upon railroads is founded upon two fundamental propositions, viz: 1st. That a wheel carriage requires less force to draw it, as the surface upon which it moves is rendered smoother, or in other words, as the rolling friction is diminished. 2nd. That upon any ordinary surface, suitable for moving carriages, this rolling friction, however diminished, is still great enough to allow a machine, revolving its own wheels, to advance, and even to carry other carriages with it. The rolling friction in this case is called the adhesion, and in fact is the propelling force. The truth of this last proposition, it is well known, was strangely enough overlooked, until after railroads had been many years in use.

Friction is, then, the cause of the propulsion of locomotives, and at the same time the limit of their power. Let us suppose the possibility of annihilating the friction betweon the rail and wheels. The drivers of an engine would in this case "slip," that is, would revolve without impelling the machine itself—on the other hand, the wheels of the cars would offer no resistance, and the slightest force would be sufficient to draw a train upon a level. The presence of friction to the slightest amount, would allow the engine to move, but would increase the resistance of the train. Experience soon taught the makers of engines that the rolling friction, or adhesion of the drivers, must be increased, and the most evident method of accomplishing this was to increase the weight of the engine, and next followed the various contrivances for throwing the weight of the tender upon the engine, and as much of both, as possible, upon the drivers.

The superiority of wrought iron over cast iron for tires or wheels led to the adoption of that material for drivers and even for car wheels. There was also supposed to be an advantage attendant upon this practice, in accordance with the law that the friction of like substances was greater than that between dissimilar surfaces. The truth of this law, in the particular case before us, is rendered doubtful by experiments on friction of high authority.

The next improvement in car wheels was the introduction of what are called chilled wheels. These insure a two-fold purpose, they wear far better than ordinary cast iron wheels, and diminish the resistance probably from the greater regularity of their surfaces, and the peculiar structure given to the metal.

Let us now consider the effect of introducing a third substance. When a locomotive has from any cause become unable to procure sufficient adhesion to the rails, a very common practice is to throw sand under the drivers, and an engine is thus enabled to proceed, which would otherwise be unequal to the task. So great is the advantage supposed to be gained by this practice that a contrivance has been attached to engines for the purpose of sprinkling sand before the wheels. We are unable to say how extensively this has been adopted, but as it is used and has been highly recommended, it may not be improper to point out all the bad consequences likely to result from its adoption. The obvious reason for the employment of sand, is the increased adhesion, but this is only attained by interposing a greater friction, which ends in injuring the rails and finally diminishing the ease with which a load may be drawn, for every time a grain of sand is pressed between the driver and rail, a portion at least becomes imbedded in the rail, and at last the friction is increased to such a degree that a resistance to the car wheels is attained which notably affects the labor of drawing a train. A fine coating of dust upon the rails is related in some experiments to have visibly retarded a train, and as this is the average of the operation upon both driving and running wheels, we have a pretty good idea of the effect of a fine layer of siliceous particles ground into the rail. In short the least examination will satisfy any one of the impropriety of habitually introducing sand or any substances between the wheels and the rail.

The presence of fluid, either in a continuous coating or in drops upon the rails is likewise supposed to retard the progress of a train. But the amount and order of effect in this case is quite uncertain. It is commonly asserted that a slight dew causes more delay than a soaking rain. That this has been proved by careful experiment is not probable, but general observation would seem to favor the truth of the assertion.

Upon this point the result of direct experiment is needed to give us any data for discussion of the subject. Theoretically speaking, the effect of dew should be more unfavorable than that of rain but the proportionate loss of power is wholly undetermined.

The presence of a film of rust upon either rail or wheel is undoubtedly productive of a retarding effect: although no means are even provided for preventing it. A very simple and yet efficacious protection would be found in applying small pieces of zinc to the wheel and rail close to, but not upon, the bearing surface. The galvanic protection of rails and wheels is impracticable in the ordinary form of "galvanized iron," but still no attempts have been made to introduce any preventive, and as the plan above proposed is so exceedingly simple we cannot but recommend it earnestly to the adoption of Engineers.

The consideration of this subject, leads to that of the effect of different kinds of surface, produced by various qualities of iron or different modes of manufacture. That a skilfull application of these varieties of surface, will lead to an increase of the maximum effect of engines, cannot be doubted. We shall reserve this branch of the question for another article. Meanwhile the hints already thrown out, may lead those who have any information, to put it in form, and give some numerical data for the further discussion of the subject.

DRAINAGE BY BORING.

The French Engineers have for several years made use of a mode of local drainage, which is almost unknown in this country and in England—we refer to the use of artesian borings, terminating in an absorbent stratum. The first application of this system was for the purpose of removing foul water from sewers and manufactories in the vicinity of Paris, where a surface drainage was impracticable, either from the nature of the ground or from the pestilential character of the water. Although from the large quantity of solid matter suspended, these borings were liable to stoppage, it was found that the absorption from two wells could be carried to 157 cubic metres per diem.

The disadvantanges attendant upon this first experiment, will not occur in most cases, in which this mode of drainage will be entirely appropriate. A recent instance in the construction of the Left Bank Versailles railway is mentioned by the French journals, in which boring was resorted to with considerable advantage. The accident is similar to those which have happened upon English and American railroads, although sometimes under circumstances preventing a resort to the remedy. We give the details as stated in the Civil Engineer and Architect's Journal.

"A large embankment was in progress to join the viaduct then building, but the deposit of earth had scarcely begun when an extraordinary motion was communicated to the adjoining soil. In two places it was lifted up eight or ten yards above the surface, the road was blocked up, and several houses on the disturbed site were upset. It was found that this operation proceeded from a stratum of clay, mixed with sand, and soaked with last year's rains, so as to become fluid; that the weight of the embankment, thirty yards high, and that of the superincumbent strata had put this pulpy mass in motion, and that it had disturbed the adjoining soil on the slope of the valley, and had in several places lifted up and broken through the upper strata. The cause was apparent that water did the mischief, and though it might not have shown itself immediately if the season had been dry, yet ultimately it would have been productive of serious evil. To remedy this, there were no other means than to stop the flow of water arriving from the upper levels; to carry which into effect it was necessary to cut the clay stratum and replace by stone work, which would surround the site on which the embankment was to be formed, and divert the water. This operation was found exceedingly difficult, having to be carried on at a depth of from six to twenty yards in a moving soil, saturated with water; it was long, very dangerous, and an accident might have wasted much valuable time, the works of the embankment being suspended in the meanwhile, and the stone work itself being liable to be swallowed up in a few years, and the work to be done over again.

Under these circumstances, the engineers thought it advisable to have recourse to boring for the purpose of absorbing the water, and applied to the General Well-boring Company at Paris. This mode was also difficult, as the boring tube got plugged up in the soft stratum as fast as it was emptied, but by means of good tools this was at last got over. The first boring reached twenty yards, and got into the upper part of the chalk, notoriously full of fissures, and where the water was rapidly absorbed. The second and third borings were carried to thirty-five and forty yards in order to get at the chalky fissures which communicate with the Seine, and feed the neighboring wells. A series of borings will therefore be carried round the embankment at proper distances and drains if necessary made to carry the water into the borings, which can easily be kept clear by means of a valve and cord. It is proposed also to apply this method to get rid of the water in sand, but this necessarily depends on the strata, for we believe that in the Kilsby tunnel it would not have been practicable."

It must, however, be understood that this system of drainage is confined to a peculiar geological formation. In the first place, such accidents are most likely to happen in *basins* where no external outlet is to be found, and where none can be constructed, either from the great distance or total absence of regular water courses. 2nd, There must be beneath the retentive soil an absorbent substratum, either of fissured rock, as in the instance cited above, or else of loose sand. The extent of the basin will of course have some influence upon the adoption of boring, as the quantity of water to be removed may be too great to find an exit through any number of borings that can be made at any reasonable cost.

There are, no doubt, many cases where a line of railway is made to deviate from its course for the purpose of avoiding swampy ground, when the perforation of a mass of hard pan or of stiff clay would remove all difficulties. This is a frequent occurrence in diluvial soil, where the absorbent stratum is close at hand.

Another application of drainage by boring, attended with great economy of time and money might be made in the common case of marshy ground on dividing ridges. The location is necessarily confined to the lowest ground, and the worst soil. The excavation is both inconvenient and costly, and generally the road bed for some distance becomes the outlet of the water. A judicious system of borings *previous* to the excavation, would in most cases, greatly reduce the expense of the grading, and preserve the track both before and after its completion from any injury by a sudden overflow of water. Often, perhaps, a well of no great depth would supersede the necessity of boring, but when the porous soil is more than a few feet from the surface no other method than boring can be adopted.

It is hardly necessary to remark that nothing of the kind must be attempted unless under the direction of an intelligent person who has some acquaintance with geology, or who possesses much local knowledge of the conformation.

The great economy of such a mode of drainage deserves the attention of the profession.

SUCCESSFUL RESULT OF THE GREAT ARTESIAN BORING AT GREENELLE.

It is well known that for several years an immense experiment upon Artesian well boring, has been carried on at Greenelle, a suburb of the French capital. In the latter end of February this undertaking was crowned with success and the heads of the Parisians well nigh turned, by the plentiful supply of water which appeared.

The boring has been conducted by Engineers Mulot, father and son. More than seven years have elapsed since the commencement of the boring, which has attained a depth of 547 metres, or 1774½ English feet.* The entire expense of the work has been 168,000 francs.

The great difficulty of working the immense borer can hardly be conceived. Four several fractures have taken place. On one occasion over *four hundred* yards of iron bars broke off, and *fourteen months* were required to remove all the pieces. At another time the bore falling an immense distance penetrated the stratum of hard chalk for 80 feet.

The quantity of water thrown out after the removal of part of the apparatus was estimated at 40 millions of litres per diem. This discharge is, however, accompanied by a vast quantity of sand, which would prove a serious encumbrance, were it expected to continue.

The entire removal of the boring apparatus gave a further increase in the supply. The water appears from experiments which have been made, to be nearly pure, at least far superior to Seine water in use.

The most liberal rewards have been given by the municipal authorities to the Messrs. Mulot, and to the workmen. The former have been indemnified for the loss they have sustained on the contract, and M. Mulot, Sen., has received the Cross of the Legion of Honor from the King.

FIRE CAUSED BY THE COMBUSTION OF CREOSOTE.

A very serious fire occurred at the depot of the Great Western Railway, by the accidental inflammation of a vat of Creosote into which a candle had fallen.

The creosote had been used in an experiment for the purpose of ascertaining its effects as a preservative for timber. The persons

* This is about 1200 feet below the level of the sea.

employed were in all probability not aware of the dangerously combustible nature of this substance, and the impurities with which it is apt to be mixed—the result of their ignorance or carelessness, was the destruction of an immense quantity of timber, besides buildings, etc., to a large amount.

This accident shows the necessity of guarding against the use of inflammable or explosive substances by persons unacquainted with their properties.

The propriety of using creosote is moreover quite doubtful, as its cost, its combustibility, its unpleasant and even unhealthy odor, are not counterbalanced by any redeeming properties—while equally effective preservatives are to be found which are liable to none of these objections.

STEAMSHIP PRESIDENT.

The prolonged absence of this vessel has given rise to the most painful apprehensions. But not satisfied with the present disquieted state of the public mind, we find some persons taking advantage of this opportunity to decry steam navigation upon the ocean, and attempting to prove that in proportion to the size of the vessel, is her danger of encountering disaster increased. The question should be discussed, when all doubt in regard to the safety of the President is removed, and by no means under the present state of excitement. A writer in the London Mechanics' Magazine, states that the delay or disability of the President, is in a measure to be attributed to a change in the form of her paddle board. Those formerly used were Galloway's patent, but some difference occurring between the Company and the proprietor of the wheel, as the former were not willing to make the proper payment, they were obliged to discontinue their use, and employ the old form of paddle board. The loss of time and power, and the danger of accident, is therefore supposed to be increased. How far the assertions of this writer are correct we are not prepared to say.

We, however, are *not* inclined to believe in the loss of the President. In all probability, the machinery has become crippled and her masts have been carried away. The aid to be derived from any jury mast that could be rigged, would be exceedingly small for so large a vessel, and consequently she has been suffered to go whithersoever the current has set. This would give her a chance to fall upon the coast of Africa, the Cape de Verds, or even the Azores, as circumstances have occurred favorable or otherwise.

There is every reason to hope that a few days, or weeks, will give us intelligence of her safe arrival in some obsure port, from which vessels do not frequently find their way to great European, or American markets.

We are able in this number to give an original communication from Mr. Klein, the assistant and companion of the late Chev. de Gerstner, in his tour through the United States. It will be remembered that we announced sometime since that an arrangement had been made to secure the regular contribution of articles from Mr. Klein. The great length of time which had elapsed without any intelligence from him, had been to us a matter of surprize, but by a recent letter, we learn that unavoidable causes have prevented his communicating with us. Mr. K. is now making a professional tour through Europe, and we hope to give our readers the result of his observations, in a regular series of papers.

For the American Railroad Journal and Mechanics' Magazine.

NOTES ON THE STEAM NAVIGATION UPON THE GREAT NORTHERN LAKES—*By L. Klein, C. E.*

The means of internal communication in the United States are furnished principally by railroads, canals, and steam navigation; all three are of nearly equal importance, and tend in a like manner jointly or separately, to facilitate intercourse between remote parts of the great American Continent, and to develope the vast resources of the immense territory occupied by the United States. But while railroads and canals have always received due attention, on the part of the engineer, and while we daily have occasion to see numerous reports and investigations on their construction, management, etc., the progress of steam navigation, in the *interior* of the United States, appears to be regarded with much less interest, and even with indifference. By communicating the following notes, for which I have collected the data on a tour over the lakes in the summer of 1839, I wish therefore, to call the attention of engineers to an interesting branch of their profession, and to occasion *perhaps some further* inquiries into this subject.

The waters in the interior of North America, upon which steam navigation is carried on to the greatest extent, and on the grandest scale, are, 1st. The rivers in the west, that is, the Mississippi—justly called the father of rivers—with its tributaries; and, 2nd. The great northern lakes. The entirely different character of these waters, in regard to the facilities they offer and difficulties they oppose to navigation, has a great influence upon the construction of the steamboats and their engines, and consequently, upon the management of the boats running upon them respectively. The difference of management produces, of course, a difference in the cost of running steamboats, which latter will be principally the object of the present remarks, in which I will speak only of the steamboats upon the lakes, reserving those upon the rivers for a future article.

There are six great lakes in the north of the Union, viz: Ontario, Erie, St. Clair, Huron and Michigan, all connected together by straits or rivers; four of them, Erie, St. Clair, Huron and Michigan, are in *nearly* the same level, and elevated from 565 to 580 feet above the Atlantic ocean; no difficulty exists for vessels of every sort to enter from one lake into the other. Thus nature has furnished the north with a magnificent basin, extending over a thousand miles from Buffalo to Chicago. Lake Superior lies 18 feet higher than Huron, with which it is connected by the river St. Mary. To overcome the falls of the latter, the St. Mary's ship canal is now constructing by the State of Michigan, and its completion will add another basin of 400 miles in length to the one above mentioned. Lake Ontario is elevated only 232 feet above the ocean, and therefore 333 feet lower than lake Erie. To overcome the mighty Falls of Niagara, the construction of a ship canal has long since been contemplated by the United States government, but will hardly be effected. In Canada, the Welland canal has been constructed for this object, it is 36 miles in length, and overcomes, by means of 34 locks, a fall of 334 feet. The dimensions of this canal being however sufficient only for vessels of 125 tons burden, steamboats can not pass by it from one lake into the other. With reference to lake Ontario, which is so much lower, the other great lakes are generally called the "Upper Lakes," and as lake Superior is not yet accessible from lake Huron—the "steam navigation upon the upper lakes" always denotes the navigation by steamboats of lakes Erie, St. Clair, Huron and Michigan.

The first vessel upon the lakes was the "Griffin," built at Erie, in 1679, for the expedition of La Salle. The first steamboat upon the upper lakes made its appearance in 1818, her tonnage was 338, while the whole tonnage of all the vessels upon these lakes amounted at that time to only 1000 tons. The want of safe harbors and of means of easy communication with the interior of the neighboring States, was the reason of the slow progress of lake navigation, until the year 1832 when by the completion of the Welland and Ohio canals and of the principal harbors on the shores of Pennsylvania, Ohio and Michigan, the tonnage had increased to about 10,000. In 1836 the upper lakes were navigated by 45 steamboats, with a tonnage of 9,017, and in 1839, already, by 61 steamboats with a tonnage of 17,324. Most of these boats are very large as will appear from the following list of 25 of them, giving their tonnage and dimensions, the port where, and the year when constructed, power of engines, and their cost and value.

LIST OF THE PRINCIPAL STEAMBOATS UPON THE UPPER LAKES IN 1839.

No.	*Name of boat.*	*Tonnage.* tons.	*Extreme length.* feet.	*Length of beam.* feet.	*Depth of hold.* feet.	*Where built.*	*When built.*	*Horse power of engine.*	*Cost or value of boat.*
1.	Illinois,	800	205 1-2	$29\frac{1}{6}$	$13\frac{1}{12}$	Detroit,	1838	196	$120,000
2.	James Madison,	630	178	$30\frac{3}{4}$	$12\frac{1}{4}$	Erie,	1837	160	75,000
3.	Buffalo,	600	189 5-12	$28\frac{1}{6}$	12	Buffalo,	1838	200	80,000
4.	Cleveland,	580	180	$28\frac{11}{12}$	$11\frac{2}{3}$	Huron,	1837	225	80,000
5.	Erie,	500	176	$27\frac{5}{12}$	$10\frac{5}{6}$	Erie,	1837	250	80,000
6.	Constellation,	484	$150\frac{1}{3}$	$28\frac{1}{2}$	$12\frac{1}{12}$	Charleston,	1837	120	60,000
7.	Michigan,	473	156	29	$11\frac{1}{6}$	Detroit,	1833	160	60,000
8.	Rochester,	472	158 5-12	$27\frac{1}{2}$	$11\frac{1}{2}$	Richmond,	1838	190	40,000
9.	Bunker Hill,	457	154 1-3	$28\frac{1}{3}$	$11\frac{1}{2}$	Black River,	1837	190	40,000
10.	Constitution,	444	140 3-4	$28\frac{1}{12}$	$11\frac{5}{6}$	Conneaut,	1837	184	47,000
11.	Thomas Jefferson,	429	174	$26\frac{2}{3}$	$9\frac{2}{3}$	Erie,	1834	150	50,000
12.	Chesapeake,	418	172	$24\frac{1}{2}$	$10\frac{1}{6}$	Maumee City,	1838	120	40,000
13.	De Witt Clinton,	413	147	$27\frac{1}{6}$	11	Huron,	1836	90	35,000
14.	Milwaukee,	401	172	$24\frac{3}{4}$	$10\frac{1}{12}$	Grand Island,	1837	150	50,000
15.	Wisconsin,	500	157	29	$11\frac{1}{2}$	Conneaut,	1838	250	65,000
16.	Pennsylvania,	395	150	25	11	Erie,	1832	180	20,000
17.	Columbus,	392	121	$28\frac{1}{12}$	$11\frac{7}{12}$	Huron,	1835	150	40,000
18.	Sandusky,	377	148	$26\frac{1}{2}$	$10\frac{1}{13}$	Sandusky,	1834	180	50,000
19.	United States,	367	140	$28\frac{1}{3}$	10	Huron,	1834	160	30,000
20.	Lexington,	364	152	$22\frac{1}{2}$	$11\frac{1}{12}$	Black River,	1838	80	30,000
21.	North America,	361	147 2-3	26	10	Conneaut,	1834	160	30,000
22.	Daniel Webster,	358	128 1-4	24	$11\frac{1}{6}$	Black Rock,	1833	100	40,000
23.	O. H. Perry,	352	146 1-6	$26\frac{1}{3}$	$9\frac{5}{12}$	Perrysburg,	1834	160	35,000
24.	Monroe,	341	144 1-2	26	$9\frac{1}{2}$	Monroe,	1834	130	35,000
25.	Chas. Townsend	313	136	24	10	Buffalo,	1835	60	12,000
25	Steamboats.	11,221						3,995	$1,244,000

The average of these 25 steamboats, is 449 tons burden, 160 horse power, and $50,000 value. There were besides, some other large boats upon the lakes in 1839, as the "New York," with 325 tons, the "Robert Fulton," with 368 tons, "Chautauque," with 340 tons, (upon the lake of that name,) "Vermillion," with 400 tons, and "General Scott," with 324 tons. The value of all the steamboats of the upper lakes in 1839, was $2,500,000.

The steamers of the lakes are built much more strongly and durable, than those upon the rivers; they also draw much more water, and have engines of greater power. The larger lake boats have generally low pressure engines, while those of the western rivers are almost exclusively provided with high pressure engines.

The steamboats are owned either by private individuals or by companies, in the latter case, the owners divide the profit in proportion to the capital contributed. They make regular trips between Buffalo, Detroit and Chicago, stopping at most of the intermediate ports, to take in wood, or to land and receive passengers and freight. Between the smaller ports a communication is separately maintained by means of smaller boats.

Of the large boats, running regularly between Buffalo and Detroit, the "Erie," is regarded as one of the finest and fastest. She was built at Erie, received her engine from Philadelphia, and is in use since 1838. Her principal dimensions will be seen from the foregoing list; the extreme width, including the wheel chambers, is 51 feet 6 inches. She has a low pressure engine with a vertical cylinder of 52 inches diameter, and 10 feet stroke; the steam is cut off at half stroke. The diameter of the paddle wheels is 24 feet, their width is 11 feet, the length of the paddles is 5 1-2 feet, being placed alternately, and divided into two compartments. The dip is 30 inches. The boat draws, empty, 5 1-2 feet, and loaded, 7 -12 ft.

The interior arrangement is not much different from that of the other lake steamers. The gentlemen's cabin, is under the spar deck, 50 feet in length, and contains 50 berths, in 3 tiers. Over this cabin, upon the lower or spar deck, is the ladies' cabin, surrounded by state rooms, each with three berths, and the doors of which open outside to a gallery. The steam engine occupies the middle part of the lower deck, between the wheel chambers, and on both sides of the machinery are the cabins of the captain, mate, engineer, the kitchen, bar and wash room, water closets, etc. In front, are the boilers, 4 in number, each 15 feet long, 5 feet wide, and 12 feet high; they reach from the bottom of the hold to some feet above the deck; at the bow of the boat, is the cabin of the fore-deck passengers, also below deck; and between it and the boilers, ample room is left for the firemen and part of the fuel. There is no space in the hold for storing goods. Two stairs lead from the lower to the upper deck, which, in fair weather, is perferred by the passengers. It is about 140 feet in length, and averages 40 feet wide; containing nothing upon it but the wheel house for the steersman.

Since May, 1838, the Erie, (captain Titus,) makes regular trips upon lake Erie, between Buffalo and Detroit. She carries principally passengers, of which she can accommodate 150 in the cabins, and a great number on the fore deck, When required, 600 passengers in all, may be taken on board. She is not intended for carrying freight, but takes it sometimes on deck. Usually, the boat stops at six or eight places on the route between Buffalo and Detroit, and performs the distance between these two ports, 360 miles, in 37 hours, includding stoppages. The average speed of the boat, while running, is 14 miles per hour; but once, she has performed the trip from Detroit to Buffalo, in 21 hours and 23 minutes; having touched, this time, only at two or three intermediate ports; the distance travelled, was 320 miles, and therefore the average speed, 15 miles per hour. Every six days, the Erie made (in 1839) a circular trip, from Buffalo to Detroit and back, and supposing the navigation to be open during eight months in the year, her yearly performance will be 40 trips, of 720 miles, or 28,000 miles.

The crew of the boat, consists of the following individuals, with the annexed salaries:

1st captain, with a salary of $1000 per annum;
1st clerk, $50 per month;
2 mates, one 70, the other $30 per month;
2 engineers, the chief engineer 600, and the assistant $400 per year;
6 firemen, each $20 per month;
8 deck hands, each $20 per month;
2 deck boys, one 10, the other $8 per month;
2 porters, one 15, the other $5 per month;
1 steward, $30 per month;
3 waiters, one 18, and two with $12 each, per month;
1 chambermaid, $20 per month;
3 cooks, 35, 20 and $15 per month;
1 barber, without salary;
1 barkeeper, do. do.;

—

34 individuals in all.

Although navigation is seldom open for a longer period than eight months in the year, the greater part of the crew is engaged and paid for nine months, and captain and engineers receive their pay for a whole year. The amount paid annually for salaries is, therefore,

To captain and engineers, - - - - - -	$2000
" clerk and mates, for nine months, - - - -	1350
" 6 firemen, 8 deck hands, and 2 boys, - -	2682
" 2 porters, - - - - - - - - - -	180
" steward, waiter, cooks and chambermaid, - -	1458
Total, - - - - -	7670

which, divided by 40, the number of trips made in one year, gives the expenses per trip, $192.

The whole current expenses per trip, (of 720 miles,) as stated by captain, (1839) are, however, not less than	$700
And consist of the following three principal items:	
1st. Salary of captain and crew, amounting as above stated, to - - - - - - - - - - - - -	192
2nd. Cost of fuel for the engine, at an average of one cord of wood consumed for every 4 miles the boat is running, making 180 cords per trip. The price per cord varies from $1\frac{1}{2}$ to $2; taking the average at $$1\frac{3}{4}$, we have as the cost of fuel, per trip, - - - - - - - - -	315
3d. All other current expenses, as for boarding passengers and crew, for bedding, washing, oil, etc., etc., must therefore, amount, according to the statement of the captain, to	193*
Total, as above, - - - - -	$700

To this sum, must be added another for the depreciation of the boat. The cost of the "Erie" was $80,000, including $33,000 for the steam engine, and $3000 for fixing the same, etc. It is generally estimated, that a good lake boat will last from ten to twelve years. If ten years are allowed for the "Erie," the annual depreciation must be taken into account at $8000, which makes per trip, $200. In this sum, we may, however, also include the cost of the ordinary repairs; as the boat and engine will have some value after ten years. We then have, as total expenses for running the "Erie," per trip of 720 miles, $700 \times 200 = \$900$, or *per mile of travel* $\frac{900}{200} = \$1\ 25$.

If we are going to compare the cost of running steamboats, with the cost of running trains upon railroads, we must, from the above $900, deduct the expenses incident to the boarding of passengers, which cannot be estimated per trip at less than $100; the proper expense of running the "Erie" 720 miles, is, therefore,

*** No allowance appears to be made for office expenses, printing, advertising, insurance, or wharfage, the amount of which must greatly augment the sum total.—*Ed.***

only \$800, or per mile of travel, $\frac{800}{720}=$ *one dollar eleven cents;* an amount which will be often found to be the expense of running a train of cars upon a railroad one mile.

In 1839 the fare for a cabin passage between Buffalo and Detroit was \$8, or 2 2-9th cents per mile, including board. A deck passenger paid only \$3 for the same distance, or 5-6th cent per mile, without board. For smaller distances the fare was, however, proportionately greater, as, for instance, between Buffalo and Cleveland, (194 miles), \$6, equal to 3 cents per mile.

The charges for freight were, from Buffalo to Detroit (up):

For heavy articles, 30 cents per hundred weight.

For light articles, 46 cents per hundred weight.

At an average, therefore, of 38 cents per cwt., or \$7 60 per ton, of 2,000 lbs., this is equal to 2 1-9th cents per ton per mile.

From Detroit to Buffalo (down) the charges were:

For flour, per bbl., - - - - - - -	20	cents.
Provisions, per cwt., - - - - - -	10	"
Tobacco, seeds, etc., per cwt., - - - -	15	"
Wool, deer-skins, etc., do. - - - - -	25	"

The charge of 20 cents per barrel on flour, and of 10 cents per cwt. on provisions, is equal to only $\frac{5}{9}$ cent. per ton per mile, (!) which is certainly lower than can be charged by any other mode of conveyance in the United States, and proves, that in regard to the rates of transportation, steamboats do not need fear competition from canals and railroads, if they can command a sufficient traffic, and the route they are going between two places is pretty direct.

The gross receipts of the "Erie," averaged per trip, about \$1200, (\$1 67 per mile). If we deduct therefrom, the expenditure of \$900, as above calculated, there remain \$300 as the nett profit, per trip, and 40 trips being made per year, the annual nett income amounts to \$12,000, or 15 per cent. on the cost of the boat. As \$8,000 for general depreciation is put under the head of expenditure for every year, the capital invested in the second year will only be 72,000, in the third year, 64,000, in the fourth, \$56,000, and so on; but it must be taken into consideration at the same time, that with the increased age of the boat, her productiveness decreases; because other steamers of later construction are coming in vogue, and offer more attractions to the travelling community.

(To be continued.)

Cast Iron Rails.—The introduction of cast iron rails in this region appears to have excited very general and deserved notice. The advantages which a railroad possesses, in every desirable quality, constructed of these rails, in place of the old fashioned wooden one, must be apparent to all who have made the necessary inquiries on the subject. A cast iron railroad cost but a trifle, comparatively speaking, more than one made of wood and faced with wrought iron; and its durability and solidity is so much greater, as to enhance its value tenfold. Let us examine into the respective cost of these roads:—

Cost, per mile, of cast iron rails, sufficiently strong to permit the transportation of a weight equal to three tons over it,	$2,650
Cost of wooden rails, faced with wrought iron, for the same distance and of equal strength.	1750
Difference,	$900

The cost of laying down the road, sleepers, etc., will be about the same on each road. The weight of the above cast iron rails is estimated at 35 lbs. to the yard, and at a cost of $50 per ton.

As we said before, the great advantage of cast iron rails is their cheapness and durability. The wooden roads used in our mines require to be renewed every three years; and the wrought iron with which they are faced, owing to the action of the water, which is greatly impregnated with sulphur, corrodes, to such an extent as to become almost worthless. Of course this objection cannot be urged against cast iron rails. The rails may occasionally break, but half of their original cost may be procured for them in that state as pig metal.

We understand that Messrs. Marshall & Co., the proprietors of the furnace in this Borough, are casting a rail weighing only 25 lbs. to the yard, suitable for drift roads, which will cost about $1,000 per mile. They have already received orders to a large amount from a number of our colliers, for these lighter rails, and but a short time will elapse before they will be in general use on this region.

Mr. Charles Lawton of this Borough, has introduced these rails in his mines, and gives the most favorable account of their qualities. He assures us that they are far superior to the wooden rails—can be laid down much easier—and that a horse—can draw nearly double the draft he formerly could over the wooden rails with their facings of wrought iron.

Railroads, canals, taxes, debts, business and profits.—An eastern paper, in going over the fiscal situation of several of the states arising out of their system of internal improvements, pauses, as might be expected, over Pennsylvania, and points to the debt on one side, and the incomplete undertakings on the other; viewed thus or viewed any way, perhaps we are in a lamentable situation, and present to the world, if the case be unexamined, a poor argument for physical improvements. But it is due to the early and steady friends of the internal improvements of Pennsylvania to say that it was not the measure, but the administration of the measure, that involved the state in its present *inconvenience*. Had a set of canal commissioners been retained at a salary suited to the services of men competent to the great work and had the whole business of letting and reletting and employing agents along the line been conducted in the way in which a man of business habits would have conducted his own affairs the state of Pennsylvania would have now been in the enjoyment of a large revenue from her public works, the lateral branches as well as the main line, and would have only half the interest to pay which she now is called on to meet. This is a fact so obvious, that we need not adduce proof. But as bad as the state of affairs now are, they can be worse, and they must be worse, unless a new system of administration is adopted. What that system should be need scarcely be mentioned, since almost any change would be for the better. We need, however, if possible, to have the whole business of internal improvements removed from the influence of party action. Principles suffer, but the effect is remote. A fiscal maladministration soon evinces itself in general disturbances. When both go together, the evil, unless timely checked, is irremediable.

If the subject of making canals and railroads was worthy of a convention, surely now that their advantages are evident, their proper management is well worthy of public regard. We must remark, "in passing," that though hitherto the income of the canals and railroads has not met the actual expenses and the interest of the investment, yet no argument must thence be drawn against the public value; because, in addition to shocking mismanagement, which may yet, and will, we doubt not, be remedied, there have resulted to individuals and the community almost incalculable benefits from the use of those improvements. Pittsburgh and Philadelphia, and the towns between the northern section and the southern section, all profit by these improvements. It is only the state, the commonwealth, that *loses;* so that while we collectively complain of the drafts upon the state treasury, it is certainly only justice to say that individual advantages have been great; and if we compare what we are now, in the way of business, with what we might be, nay, should have been, without canals and railroads, we certainly have some cause for felicitation.—*U. S. Gazette.*

RAILROADS.—Ten years ago, railroads, as a means of general transit for passengers and goods, were almost untried. Now, they are spreading over the country like a net-work; about one hundred and fifty railroads are already in use in Great Britain and Ireland, and upwards of sixty millions of money are invested in them. They are upsetting all our former notions and altering our social condition; they are pouring the country into London, and spreading London over the country. Northwards we are carried as far as Lancaster, a distance of 241 miles from London, in eleven or twelve hours, by the London and Birmingham, Grand Junction, North Union, and Lancaster and Preston; where, though for the present it stops, there will no doubt be a continuation by Penrith to Carlisle and Glasgow. The same lines link with Wigan, Bolton, Manchester, Liverpool, etc. At Rugby, 73 miles from London, on the London and Birmingham line, the Midland counties carries us to Nottingham and Derby; and at Derby we can get, by the North Midland and its junctions, to Chesterfield, Sheffield, Leeds and York; or, instead of going on to York, we may double, like a hunted hare, turn to Hull by Selby, or from Selby to Leeds. At York, the great north of England railway, now in progress, will carry us to Durham and Newcastle; and at Newcastle we can cross the island to Carlisle. Returning to London, we find the great western railway opening to us the western coast, and by it and its western junctions, not only enabling London citizens to spend a day comfortably at Windsor, but joining Bristol and Bath, Gloucester and Cheltenham, either now or shortly The south coast again, is also free to us by the Southampton and Brighton railways, along with the Greenwich and its adjuncts, to Croydon and Dover—all either made or making. Again, the northeast coast is accessible, by the eastern counties, and a railway to Ipswich and Norwich; and all who wish to avoid the intricacies of the London portion of the Thames, called "The Pool," or who are in a hurry to reach a dinner of white bait, can be whirled from the city to Blackwall.—*London Chronicle.*

REPORT OF THE ENGINEER UPON THE SEVERAL DEFINITE LOCATIONS FOR THE HARTFORD, AND SPRINGFIELD RAILROAD:

HARTFORD, MARCH 2ND, 1841.

(Continued from page 288.)

5. POQUONOC AND SUFFIELD ROUTE.

All the lines heretofore described most naturally make their southern terminations in the northern and eastern portion of the city of Hartford; affording, however, a ready communication with the depot of the Hartford and New Haven railroad company, either by passing through the city with horse power or by curving around on its western border. The two lines next in the order of description most naturally have their terminating points in the western part of the city. The map will indicate different proposed lines surveyed for forming a connection from them with the river navigation. The detailed estimates show that the expense of connecting the eastern lines with the Hartford and New Haven railroad depot, will not be greater than the cost of connecting the river interests with these western routes, unless a grade of fifty feet descent to the mile is adopted, then the western lines will have a decided advantage in forming such connection, or the main line may terminate as indicated on the map, at a lot on the north part of Main street, from which a branch line may pass easterly to the river, and another southerly to the depot of the corporation before mentioned. This would, however, require grades of sixty feet to the mile. I now invite your attention more minutely to the particular line under consideration. This commences at a point on the superstructure of the Hartford and New Haven railroad, situated one thousand feet west of the depot of said road; from this point the line deflects to the north, with a level grade, on a curve having a radius of fifteen hundred feet, and terminating at a tangentisal point on the southern border of Asylum street. It is obvious that the line may pass the street named at various places east of its present location. This particular crossing, however, is chosen with a view to pass the train of cars, under that great thoroughfare, through an arch or covered way, and to continue the same in such a manner under the surface of the lands intervening between this point and the river, as to leave unimpaired that beautiful estate with its pleasing associations. For this purpose the grade of the street will require to be raised from four to five feet. Various other plans for crossing this street, with and without locomotive power, are herewith presented (marked D.) From the termination of the curve just mentioned, the tangent takes a northerly course, encountering a succession of moderate cuts, until it arrives at the Poquonoc factories on the Farmington river; crossing that stream, the line, after making a slight curve to the east, has, in general, a direct course along the level ground east of Suffield; passing over the plains south of Agawam, it descends with a moderate grade into the valley of Agawam, crossing the Agawam river, and turning on a radius of two thousand feet, with a level grade, it unites with the Western railroad, as shown on the map. This is a cheap route in most respects, and when definitely located, will be to a small extent, shorter than any practicable line that can be run between Hartford and Springfield.

It is necessary to adopt two grades of forty-five feet to the mile, on a a straight line, or to build an embankment at the Poquonoc factories of the height of sixty feet. Judging from recent suggestions that I have received from gentlemen well acquainted with the country in the immediate vicinity of this line, I think it important that some further examinations should be made.

6. RAINBOW AND SUFFIELD ROUTE.

This line crosses Asylum street in the manner proposed for the Poquonoc and Suffield line; from this street the line is straight, bearing north 2° 7', east for about ten miles, which brings it to the Rainbow factories, on the Farmington river, and which are situated nearly midway between the factories at Poquonoc and those at Tariffville; from this point, after describing a curve, bearing to the east on a radius of 5000 feet, the line continues direct, bearing north $25\frac{3}{4}$° east for about thirteen miles, and until it has crossed the Agawam river, and commences the requisite turn to unite with the Western railroad, as shown on the map.

This line passes the Farmington and Agawam rivers at the most desirable points. The foundation for the bridge at the Agawam must be placed on piles below the bed of the stream. The crossing at the Farmington river may have natural rock abutments to the height of forty feet; the piers will also rest on a rock foundation. By curving the line eastwardly, as indicated on the map, it may pass along on the eastern side of the Windsor plain, and cross the river at any desirable height above the water not less than forty feet. On the line just mentioned, the piers require to be built to the height of sixty feet. Sufficient soundings and other examinations have been made to enable me to state with confidence, that neither clay, quicksand, hardpan, or rock, will be found on this route, unless clay occurs to a small extent near Hartford. I ought here to remark that by breaking those long straight lines into various lengths, and locating moderate curves between them, some fifteen or twenty thousand dollars may be saved in the expense of grading.

7. BLOOMFIELD AND SUFFIELD ROUTE.

This line was run because the face of the country showed that it could be graded at less expense than any other entire line; but its increased length forms an objection which is not compensated in the diminished cost of grading.

BLOOMFIELD AND MIDNEAG ROUTE.

I have been requested to survey another level and very feasible route, passing through Bloomfield, Turkey Hills and West Suffield, and having its termination on the Western railroad at Midneag. The additional length of three or four miles which this line would have as compared with some of the routes described above, will not form the only objection that can reasonably be brought against it.

Having given a general description of the several routes, it now remains to arrange in tabular form the elementary data on which a judgment, respecting the character and expensiveness of your contemplated railroad, must be formed.

LENGTH OF THE VARIOUS ROUTES IN MILES.

East line, extending from Front street in Hartford to the depot of the Western railroad in Springfield,	25.37
Same line, extending from the H. & N. H. R. R. depot to the W. R. R. depot,	26.37
East line on east bank of river, extending from from Front street in Hartford to the depot of Western railroad,	24.89
Same line, extending from depot to depot,	25.89
Combined East and West line, crossing at the foot of the falls, measured from its intersection with H. & N. H. R. R. to the depot of the W. R. R.	24.95
Same line, measured from depot to depot,	25,14
West line on the west bank of river, measured from its inter-	

section with H. & N. H. R. R. to its intersection with W. R. R.,	24.27
Same line, measured from depot to depot,	24.72
Poquonoc and Suffield line, measured from H. & N. H. R. R. to Western railroad,	23.77
Same line, measured from depot to depot,	24.68
Rainbow and Suffield line, measured from H. & N. H. R. R. to Western railroad,	23.91
Same line, from depot to depot,	24.60
Bloomfield and Suffield line, from H. & N. H. R. R. to W. R.	24.62
Same line, from depot to depot,	25.53

SUPERSTRUCTURE.

The necessary excavation upon your route, will afford, in almost every instance, the best material for the road bed. Where this is not the case, a suitable bed for the superstructure must be prepared by excavating a trench, say eight feet in width, and three feet in depth, and filling it with clean sand or fine gravel. The following estimate for a superstructure of the most durable kind, is based on the most approved edge rail, of the ⊥ pattern, weighing 50 pounds to the linear yard. This is only 6½ pounds less than the weight of the rail of the same pattern in use on the Western railroad, where it is required to sustain, upon curves much smaller than those upon this road, the action of such heavy engines as may be required to surmount the maximum grades upon that road of about 80 feet to the mile. The Long Island railroad, which cannot be characterized as being more favorable than yours in point of grades, or curvature, has a rail of the same pattern, weighing 40 pounds to the yard; and this is heavier than some of those in use on similar roads in Europe.

ESTIMATED COST OF ONE MILE OF SUPERSTRUCTURE.

21,120	feet (board measure,) of longitudinal ground sills, 8 inches wide by 3 inches, at $13 per M.	$274 56
5,000	feet of bearing sills at the joints,	65 00
1,760	sleepers, 7 feet long by 8 inches thick,	492 80
78½	tons of iron rails, at $50 per ton,	3925 00
704	cast iron chairs, (weight 10 pounds each,)	340 00
9,152	spikes, at 6 cents per pound,	274 56
	Laying rails, trenching, etc.	450 00
	Distributing materials,	235 00
		$6056 92

Proposals are herewith presented on which the above estimate is based in part.

ENGINES AND CARS.

It is a fact well established by experience, that you do not necessarily double the expense of operating a railroad when you double its length. Strict economy, therefore, requires that contiguous corporations should unitedly operate their respective roads with the same cars and attendants.

The fortunate situation of your road gives a desirable position, from which you may negotiate on either hand with your enterprising neighbors.

It may be desirable, however, under certain circumstances, that this corporation should operate its own road. I therefore present you with the following estimate.

Three locomotives and tenders, - - - - -	$19,000
Ten passenger cars, - - - - - -	10,000
Twenty burthen and baggage cars, - - - -	8,000
Convenience at Hartford, - - - - - -	8,000
Amount, - - - - - -	$45,000

BRANCH LINES.

The expense of short branch lines connecting some of the most essential interests at the Hartford termination, will require an expenditure of nearly $25,000

LAND AND DAMAGE.

We have endeavored to ascertain since the 20th of February, the amount it would be neceseary to pay for the land, damage and fencing, on four of the entire lines surveyed for your road. It is but justice here to observe, that our applications for terms have met in general with the most favorable reception. Although we have not obtained a sufficient number of bonds on all of the routes, to enable us to make an accurate estimate of the expense of each line, it is not to be inferred from this circumstance, that the proprietors entertain an unfriendly disposition in regard to this enterprise.

In crossing lands of great value, it necessarily requires considerable time, to ascertain the proper amount to be allowed for damage. This is the main reason why we have obtained so few bonds upon the river routes.

In a few days we shall probably have bonds from most, if not all of the proprietors.

The land and damage charged in the 100 bonds obtained on the east line, is 17,213 dollars. I am under great obligations for my success in this part of your enterprise, from the assistance that I have received from Mr. William Allen, a young engineer with whom you are favorably acquainted.

By your written instructions I am required to present an estimate based on proposals from responsible contractors, to grade and finish in the most substantial and thorough manner, your contemplated railroad in all of its parts, by the first day of January next. And bonds under seal, duly executed, were to be procured in order to ascertain the requisite amount of land and damage expenses. These duties I have performed according to the best of my ability; the result is before you. I cannot at this time complete the estimate for the four first routes named, because the bonds for the land and damage could not be procured in so short a time. But upon the route last named the proper bonds duly executed have been generally obtained, which enables me to present the estimate on the required basis, as follows:

Cost of road based on bonds for land and damage, and proposals from responsible men for its construction,	$369,657 11
Contingencies,	50,000 00
Amount,	419,657 11

ANNUAL EXPENDITURE.

The expense of repairs for the road and engines, and all contingent outlays for operation of this kind, are easily calculated from experience and known data, derived from different roads in this country that are in actual use. For the number of passengers with which this road would open, there must be two trips and two return trips each day throughout the year, except Sundays. An allowance must also be made for the salaries of the various officers, and for the repairs of the road, engine, cars, etc. I estimate the necessary outlay for these objects for one year, at $20,000.

RESOURCES OF THE RAILROAD.

In deference to the common practice, a statement may be expected showing the basis, in a pecuniary point of view, upon which the friends of this laudable enterprize invite the co-operation of a discerning public. From the certificates and documents herewith presented the following results are obtained.

The number of passengers through between Hartford and Springfield the past year in stages, has been 21,526.

Amount paid for passage,	$33,289 00
Do. do. Way travel	3,400 00
Do in the river boats, variously estimated at from 8 to 12,000, at $1—say,	8,000 00

Way freight 13,000 tons. Present cost of transportation about $20,000. This will nearly all pass upon your road in the event of a particular location, which, though not certain, is as likely as any other—say from this source, $12,000 00

The unoccupied water power in the immediate vicinity of this road, on the Farmington river, and at the fall of the Connecticut, is unsurpassed, even by Lowell itself.

When your road is constructed to Springfield, the large number of passengers, who now find it for their interest and convenience to leave the valley of the Connecticut river and take an easterly direction across the country to Worcester, then a southerly direction over the Norwich and Worcester railroad, will no longer find it for their advantage to pass over the two sides of a triangle, when they can arrive at the same point, by passing over its third side.

The amount of this travel is estimated at from ten to fifteen thousand passengers—say from this source, $10,000

The amount of long travel from the east is variously estimated at from 50 to 100,000 persons. During the past season they have found it good economy both in time and expense, to pass between New York and Boston over either the Norwich and Worcester or the Boston and Providence railroad. Construct your road in the manner proposed, and the aspect of things will be completely changed. Instead of being four or five hours on the road between Hartford and Springfield, they will then pass this link of the great chain in forty-five minutes. A passenger can then be carried through from New York to Boston during the summer season, by day light. In the winter season the increased inconvenience arising from the navigation of Long Island Sound, is a sufficient reason why travellers will continue to prefer the inland route. Considering that passengers will gain nothing of moment in economy or time by taking any other route from Boston to New York, and that the line of which your road forms a connecting link, passes through a densely populated country, and in the immediate vicinity of some of the most flourishing colleges and other literary institutions in New England, surrounded on all sides with the most beautiful scenery—is it too much to estimate, that one-third of the long travel will pass this way? I estimate the increased income from this source by adding only $10,000

The amount of imports and exports that pass Hartford from the valley of the Connecticut, is stated at 30,000 tons annually. It is believed that the up river freight can be taken from the wharves in Hartford and delivered at Springfield, as reasonably as if taken up the river and through the canal; especially will this be the case with articles of considerable value.

Estimated from this source, $4,000

From the report of Mr. Twining on the preliminary surveys of the Hartford and New Haven railroad, the following statement is made.

"There are now in Springfield and the region round about it, 60,000 spindles in operation, and these I should judge (as 28,000 of the number are stated to consume 8,000 bales of cotton) must create a transportation to and fro of six or seven thousand tons, and probably this same region, when its power shall be fully taken up, will transport five times or even ten times its present amount. A large amount of the cotton to feed these establishments would pass on your railroad, as the new crop does not come in till the river is about closing."

The transportation accounts on the Hartford and New Haven railroad prove the correctness of this statement in relation to winter freight. We can, therefore, safely increase your estimate from this and contiguous sources. 9,000

Tor transportation of mails, add 3,000

The fact is well established that business and travel are much increased by opening a continuous line of railway. Your route cannot be an exception, because it will re-establish the broken links in the old highway between the east, south and west—because it will best accommodate the southern business of a population of more than half a million, residing at present in the valley of the Connecticut; because upon the borders of this great river and its branches, there is according to the report of the Windsor Convention, a water power at present unoccupied, of sufficient magnitude to operate during the season of greatest drought, more than 1000 cotton manufactories, capable of driving more than 4,000,000 spindles.

I cannot close this report without acknowledging the obligations which your corporation and the engineer corps are under for the friendly acts and great assistance received from gentlemen residing on the line of the surveys. I herewith transmit to you the names and residences of those to whom you are under especial and particular obligation. I have also appended a list of those gentlemen who have given bonds to convey to your company the right of way without any pecuniary compensation whatever, and recommend them to especial consideration during the future operations of the road.

All of which is respectfully submitted,

by your obedient servant,

JAMES. N. PALMER, *Engineer.*

To the Surveying Committee of the Hartford and Springfield Railroad.

GENTLEMEN:—By the request of J. N. Palmer, your engineer, I have examined partially in the field, but more particularly the data on which his estimates are based, and from the peculiar adaptation of the countryfor the purposes of a railroad, and the generally good feeling of the land owners. Mr. Palmer has been enabled to make you a low estimate in comparison with other roads of the same length.

The estimates being based as they are, on actual and responsible bids for the construction, and the land damages on actual bonds in your possession, it appears impossible there should be any great discrepancy between the estimated and actual cost, but in order to meet all possible contingencies, it was mutually agreed to add fifty thousand dollars to the estimated cost.

The difference of estimate between Mr. Palmer and Mr. Twining, is easily accounted for by a careful examination of their respective reports.

Yours, etc.,

P. Anderson, W. R. R.

PRIMING OF LOCOMOTIVES.

It will not, perhaps, be thought that we are dilating too much on this part of the subject, when it is considered what immense sums of money have been expended in running after that *ignis fatuus* steam locomotion on common roads, and ending after all, as has been observed by some one, in bringing us to the humiliating conclusion, that *a sixteen horse power engine will not propel a four horse coach.* Now the priming or the flushing of the boilers, which are necessarily of very small dimensions, is acknowledged on all hands to be the principal difficulty that the various projectors have had to encounter; consequently, there arises the necessity of using steam of two or three hundred pounds per square inch, as appeared by the evidence of Mr. Gurney and others, before the parliamentary committees a few years ago.

It must not, however, be taken for granted that we assent to the first of the above conclusions as containing any thing in the least discouraging to any intelligent projector of steam carriages. For who that really deserves to succeed ever expected that less than a sixteen horse engine will be required to drag a four horse coach upon ordinary turnpike roads, when probably one half of the power of the engine is required to propel itself. The only difficulty as to the engine, is to have a sufficient power in the smallest possible space; to effect which, there can be no doubt that the reciprocating principle, with all its rods, guides, cranks, and crooked contrivances must be entirely thrown overboard, and a simple and effective rotary engine substituted. It is, however, well known, that amongst all the difficulties steam carriage makers have had to contend with, the boiler has always been the grand rub. That being, as it is termed by the eccentric Col. Maceroni, the very "soul" of a steam carriage, and as it is, indeed, of any other sort of steam engine.

Although the steam chambers of the boilers of railway locomotives are not so confined as those just mentioned, yet we venture to affirm, from a general knowledge of the working of the travelling engine upon railways, from its first introduction into the county of Durham in 1815, and a pretty close attention to the numerous alterations and improvements attempted on the Liverpool and Manchester railway, from its opening up to the present period, that the want of sufficient steam room has been the cause of some of the greatest difficulties that railway engineers have yet had to contend with, however unwilling they generally are to admit the fact. How far increasing the gauge of the railway, as is now being done by Mr. Brunel on the Great Western line, will tend to lessen the enormous* expense of railway travelling, by admitting the possibility of using larger boilers as well as larger wheels, remain to be seen.

It is a fact of the very utmost importance, and deserves the attention of

* In this and some other statements, allowance must be made for the authors want of acquaintance in the railroad engineering, which we believe is not his department. He appears, probably from this cause, somewhat bound upon these points. [Ed. R. R. J.]

those interested in railway speculations, that the very large item of expenditure in the reports of the Liverpool and Manchester company, under the head of locomotive power account, varying from 30 to 40,000*l.* per annum, is, in part, the result of want of sufficient boiler room. In saying this, it is not meant that larger boilers than those at present in use by that company are at all practicable on their line of railway; and much less is it intended to cast the least reflection on any part of the direction, for there has been no lack of zeal in every one concerned in the management, to adopt every possible expedient that promised any chance of abatement under this head of disbursments; it is only mentioned to show the necessity of railway directors generally, attending more to this point. Science has, as yet, done little or nothing for them; indeed the common fault of railway directors is too great a tendency to adopt the suggestions of mere scientific gentlemen, or the schemes of amateur engineers, because their ideas happen to be clothed in a scientific dress, in preference to plain, practical, and inexpensive improvements of a less ostentatious character.

The numerous improvements of the ingenious Treasurer* of the Liverpool and Manchester company, apparently with a view to avoid the alternative of very large boilers and a reduced speed, and the many curious contrivances adopted from time to time to prevent the priming of the boilers, are proofs that those who have much experience in this matter, consider that in using larger boilers the remedy would be as bad as the evil it is proposed to cure; it is, therefore, now generally admitted that the profitable application of steam to *rapid* railway travelling, is yet surrounded with peculiar difficulties, all of which tend to the conclusion, that although the steam engine is an agent of almost unlimited capabilities, still it has, as yet, resisted all attempts to confine it as it were in a nut shell.

If the boilers are made larger and heavier, the destruction of the rails will be greater, besides the danger arising from the increased momentum of the engine in case of accident; on the other hand, if we work with smaller boilers we must have a higher pressure of steam, and then there is the greater destruction of the grate-bars and fire boxes, by the necessarily increased temperature of the furnace, which must render journeys of much greater length than thirty or forty miles with the same engine to be very uncertain and precarious, besides the danger and delay attending the continual giving way of the tubes. Again, if we attempt to use the steam at a moderate pressure, although fully equivalent to a reasonable speed, there is the constant liability of the water to prime over into the cylinders, from whence it is forced, by successive blows of the piston, through the funnel of the chimney, to the great detriment of the whole of the machinery, more particularly of the cranked axles, which, on this account, require to be of such enormous strength; in fact, when the engine primes, the piston is acting for some time like the ram of a powerful force pump or water engine, and the resulting effect must depend upon the acquired momentum or velocity of the engine at the time, and the strength of the parts. Any one may observe the effects of a locomotive engine priming, in a fine shower of spray from the top of the funnel, immediately on reaching the bottom of any considerable inclined plane, unless the speed is previously slackened or the regulator used with extreme care. Hence we may well doubt the

* H. Booth, Esq., of Liverpool, the inventor of the present form of locomotive boiler with numerous tubular flues, whose unremitting perseverance, combined with the united talent of the various able engineers and mechanics of the establishment, has rendered the locomotive engine, *as adapted to their own line* and their present arrangements, as to speed and passenger traffic, perhaps incapable of further improvement.

applicability of this engine to long lines of railway; the defect seems to lie in the *principle* which apparently involves the necessity of wire-drawing the steam, and is not to be easily removed by any mechanical arrangement whatever. In the locomotive engine, in its most improved state, the steam is in fact throttled at both ends—that is, both in the *induction* and *eduction* pipes.

Notwithstanding that the boilers of the locomotive engines on the Stockton and Darlington railway have been generally modifications of the old, or Trevithick plan, with a much greater capacity in proportion to the heating surface, than the multiflue boiler of Mr. Booth, and therefore, generally considered to be on a less economical principle as to the application of heat, it is well known, that the cost to the company for drawing each ton per mile on the level, is not one half of what it is upon the Liverpool and Manchester line. The fact is certainly not in favor of high speed and high pressure; the speed of the Darlington locomotives being about 12 to 15 miles an hour, which appears to be the velocity that gives the *maximum of useful effect*, while the pressure of the steam is only about 40 pounds on the square inch. And we have had an opportunity of ascertaining, from a long series of very careful experiments, that even this pressure is still higher than that which is found to produce the best possible effect in a stationary engine, when working without either governor or throttle valve, as is the case with locomotives.

The superior economy of the Durham engines, is, no doubt, in part, owing to the use of coal instead of coke, and not being compelled to burn their smoke, (as they are obliged to do on most of the Lancashire railways,) and this fact, it may be observed by the way, says nothing in favor of smoke-burning. It may also be stated, that but for the invention of the blast pipe, by Mr. Timothy Hackworth, which, in conjunction with Mr. Booth's boiler, at once doubled the efficiency of the locomotive engine, the prevention of smoke on railways would probably still present as great a difficulty as it yet does in factories.

While on this subject we may just state that the original "Sanspariel," of Mr. Hackworth, which all but successfully competed for the prize at the opening of the Manchester and Liverpool railway, may still be seen regularly working on the Bolton and Lehigh railway, apparently not much worse for seven years constant work, the boiler never having required any essential repair, while its contemporary rivals that have escaped the fate of the "scrap heap," have been re-made, and mended over and over again, since the celebrated race at Rainhill—a fact which goes far to prove that the principle of this engine has not been so very much improved upon, except that it is not so well calculated for burning coke as coal. The Sanspariel may frequently be seen at the Kenyon Junction, waiting for the Bolton trains from Liverpool, and plans of it may be seen in Dr. Lardner's work Heberts' Mechanics' Encyclopædia, Wood on railroad, Mechanics' Magazine, and many other works.

PRIMING OF FACTORY ENGINES.

The steam in a common factory boiler, for working an ordinary condensing engine in a factory, is usually of about two pounds per square inch greater pressure than the average pressure on the piston throughout the stroke, and with this condition, we have never found an instance of a boiler having much less than half a cubic yard for steam room* per horse power, that was able to do its work properly. This proportion may be depended on, as the result of no very limited experience, being from actual personal examination and measurement of several hundred boilers, with a view principally to the determination of this particular datum; and it fortunately happens, that the circumstance of a boiler priming into the cylinder, not only gives visible and audible signs of its taking place, but also leaves, in some measure, permanent traces of its having done so, sometimes in the cylinder, but almost always in the boiler, so that the accuracy of our experiments on this head may be easily tested.

Where the engine, or rather the boiler, is overworked, and the load on the engine not very regular, experiments to the foregoing effect may be said to be going on almost daily, and in many cases, even without the owner being aware of any thing of the kind, until his engine has been broken down a few times, and after the expenditure of a few hundred pounds: then (as it is commonly, but expressively, said in Lancashire) "*he finds it out.*" In fact, the want of sufficient capacity of steam chamber entails upon us the choice of two evils; one is the risk of breaking some part of the engine (generally the crank or crank pin) by a sudden flush of the water into the cylinder, the other is the constant tear and wear, and eventually the danger of bursting the boiler, by too great a pressure of steam.

Instances are sometimes met with, where double the above proportion of steam room is not sufficient to prevent the boiler from priming occasionally, but there is in such cases always some special circumstances to account for it; for instance, where there has been any neglect in cleaning the boiler, and a considerable portion of the load is suddenly thrown on, when the engine is already running at a good speed, and particularly if there is at the time a sharp fire under the boiler capable of suddenly generating a great quantity of steam. This, it will be perceived, is nearly a parallel case to that of a locomotive at the foot of an incline, as already mentioned. Cases of this kind frequently occur at calender houses, saw mills, and machine shops. In the latter it is rather disgraceful, because the managers of such places, if not engineers, ought, at least, to be experienced mechanics; but in Lancashire there are more than two or three such concerns which seem determined to verify the old saying, that "shoemakers wives go the worst shod." Mere neglect may be sometimes excusable, but there is too often sheer ignorrnce of the worst kind. Some of their proprietoss have for years been acknowledged as the first mechanics in Europe, and justly as they may lay claim to be so considered, from the magnitude of their establishments, it is painful to find that they have much to learn in respect of their engines and boilers.

The presence of some kinds of dirt in the water, particularly if it be of a mucilaginous nature, is liable to cause the engine to prime, whatever may be the amount of steam room. A small quantity of soap has a wonderful effect in this way; and generally speaking, with a dirty boiler and a full load on the engine, there is a *continual* "*flushing*" of the water in the boiler, or an *attempt* to "prime" at every stroke of the engine. In these cases we usually find that the dirt has partially left the boiler and passed into the cylinder, thereby seriously injuring the packing of the piston and valves, and causing an immense waste of tallow and fuel, besides requiring perhaps two engines to do the work of one. We know of nothing that has been so detrimental to, and so long delayed the successful introduction of Mr. Bartons metallic packing for pistons,—decidedly the most important improvement in the steam engine since the days of Watt.

For all such cases, however, there are various preventive remedies which will come more properly under our consideration in another chapter; the principal of which are the adoption of various mechanical methods of frequently cleaning out the boilers, or rather of preventing them from becoming dirty. We shall now advert in particular to an apparatus, which effects the latter purpose very completely without the necessity of emptying the boiler, and without the least interruption of the continued working of the latter, or the engine to which it is attached. And we shall endeavor to do so here, at the unavoidable risk of being thought egotistical, the apparatus in question being partly contrived, or rather improved, and wholly adapted to its present purpose by the author of this work; not only because it has an important relation to the subject now in hand, namely, the priming of steam engines, but also because, since the publication of our first edition, we have had reason to believe that the apparatus is not so well known, ahd where known, not so well understood as we had previously supposed.—*Armstrong on Steam Boilers.*

ANTIQUITIES OF CENTRAL AMERICA.

The New York Albion furnishes a brief account of the important discoveries of Messrs. Stephens and Catherwood, in Central America, or Guatimala, as it was formerly called. Our readers are aware that the attention of the learned has been much directed, of late, to the numerous and astonishing monumental treasures that lie scattered about this vast region. The two gentlemen above named have recently returned from an extensive survey of these ruins, and are about presenting the result of their explorations to the public in a printed volume. In the mean time, in order to satisfy in some degree the public curiosity, they have delivered several lectures on the subject, the general conclusions of which are presented in the Albion.

The travellers proceeded from New York to the bay of Honduras, and, upon landing, their first halting place in the way of their task was *Copan* the ruins in the vicinity of which were both extensive and magnificent. Mr. Catherwood, on Wednesday evening, exhibited a drawing of a temple at *Copan*, which seems to have been upon an extensive scale, one front of it being in length about 230 feet, and its side face about 180 feet. The interior of the temple is laid out with all the skill and regard to convenience of the most practised architect, and the exterior presenting an elaboration of ornament as well as refinement in sculpture, which altogether astonished the travellers, as in fact so did the drawing astonish those before whom it was placed at the lecture. There were many single columns most elaborately wrought, the work was deeply cut, and all in masterly style.

From Copan the travellers proceeded to Kuirigui, where they found many monuments, chiefly of the same character as those at Copan, only the latter were much longer than those which were first visited. From thence they proceeded to Santa Cruz del Cuiche, to Guequetenango, to Ocosingo, to Palenque, and to Uxmal. The whole forming a circuit of nearly three thousand miles in perimeter, and the greater part of which was thickly studded with extensive ruins, all of which were analogous to each other, although the variations in extent, ornament, etc. were numerous. They were all evidently the labors of a people of a common origin, of apparently the same political, religious, and social principles, of the same habits and associations of ideas, and certainly far advanced in civilization and refinement. Innumerable square columns or obelisks of stone were found in the course of their investigations, all of which were carved on every side with hieroglyphics, or with figures of animals or human beings; the former, in all probability, containing legends which, if they could be deciphered, would go far to explain the history of the people who had thus executed them; and the latter executed with such regard to the due proportion of figure as actually to astonish the travellers, who had not the most remote expectations to find any branch of the fine arts in so forward a state. What added to their astonishment was the fact that all these monuments were found in the deepest recesses of forests of gigantic and closely planted trees; a proof of their antiquity altogether irrefragable, as it must have required centuries to bring such trees to their maturity and enormous growth, and it must have been after those cities were ruined and gone to destruction that those forests were allowed to take root in their precincts at all. These considerations, unaided by any other, must carry the mind back to a period of the world altogether startling to think of.

An erroneous notion has got abroad that these antiquities, in the colossal magnitude of their parts, throw those of Thebes, Luxor, and other Egyptian monuments in the shade, and that the latter may now "hide their diminished heads;" it is believed also that in architectural elegance, as well as in extent, these American remains far exceed those of Balbec, Palmyra, or even ancient Babylon itself. These surmises receive no countenance from the accounts given by Messrs. Stephens and Catherwood. The extent of the American monuments has rather regard to them as one mass promiscuously and almost everywhere spread within a circumference of three thousand miles, than to the extent or magnitude of any one specimen or set of ruins; and nothing but either a complete misunderstanding of the true details, or an intense love of the marvellous, could have brought about those false comparisons.

But the most important point to be ascertained is that of referring these monuments truly to any of those of the old world. At the first glance at some of the more colossal figures, their costumes and their groupings, there was for the moment a similarity to those of ancient Egypt, but the practised eyes of our travellers soon corrected the momentary error of their thoughts. There was not one of those monstrous heads which so essentially belong to Egyptian mythology, religious rights, and occult writings; the proportions of the figures were in every respect better in those before them, and nowhere did they find that inherent regard for great magnitude or peculiar position in the statuary and sculpture. The hieroglyphics too, though liberally scattered and everywhere homogenous, were altogether different from those upon the Egyptian monuments. From the intricacy of their designs, and from many grotesque subjects of their sculpture, these monuments might be referred to a more oriental source than that of Egypt; and the similarity seems to increase the further they are referred to the eastward. China and Japan present many of the images and groups which are found on the American monuments; and although with much that is grotesque, in the latter there is also much that is beautiful and symmetrically correct, while in China and Japan, particularly the latter, the monstrous prevails in an exorbitant degree, there is really much that is common to the east of Asia, and to the west of America.

With data like those before us, then the editor of the Albion asks, can there be much difficulty in fortifying that most received hypothesis, that America was first peopled from the eastern part of Asia, the passage being made across Behring's straits? Where is the difficulty in assuming the theory that mankind, continually radiating from the primitive seats of first creation, and continually advancing beyond previous confines, should gradually arrive at the western shores of the Pacific, should people the islands there, should cross the narrow straits—so narrow that at midway both shores may be seen from the same position--should travel southward, and give a human population to this continent?

The following extract is from a paper entitled, Brief Observations on the State of the Arts in Italy, etc., by Chas. H. Wilson, Architect, Edinburgh; read before the Soc. of Arts in Scotland. Many good things are to be found in this paper which is, however, too long for insertion. We shall content ourselves with a few other extracts.

STATE OF ENGINEERING IN ITALY.

I shall now turn to the engineering works of Italy, a subject worthy of much attention, but on which, I regret to say, I am able to say very little indeed. The greatest works I saw going on were those at Tivoli, and from the Ombrone to the Lake of Castiglione in the Tuscam Maremma. I shall merely offer a very brief description of these works, necessarily very imperfect, as I write entirely from memory. The Tiber or Aniene, on reaching Tivoli, was dammed up by the architect Bernini; precipitating itself over the lofty barrier he raised, it disappeared under the rocks on which the town is built, and was seen again in the celebrated grotto of Neptune; rushing out of this remarkable cavern, it feil into another abyss, and again vanished into the grotto of the Sirens, from whence it issued in the deep valley under Tivoli, several hundred feet below its original level. The pencils of the painters of every nation have been employed for centuries with this, I may say, terrible scenery, this *orrido bello* of the falls of Tivoli. They may now depict the rocks, but the waters are gone for ever. Some years ago, Bernini's dam was carried away in a flood: it was rebuilt by the Pope's engineers; but, if I remember aright, the river got the better of them, and threw down their work; at last they dammed up old Tiber, and made the very ugliest waterfall that ever unfortunate artist contemplated. It was discovered that the river, in passing through Neptune's grotto, had worn away the rocks in such a manner that the town and its temple depended on a rugged pillar, the duration of which could not be calculated upon. To prevent the town paying a visit to the Sirens beneath, it was resolved to turn the river, and it will be acknowledged that this was a bold undertaking; walled in by mountains, it sought a passage under them; and to a certain extent imitating the operations of nature, the engineers have carried the river through two parallel tunnels, and tumbled it into the valley beyond the Sirens' grotto, over a bank twice or perhaps three times as high as the Calton hill. I have made a plan from memory of this operation, as the best mode of explaining it. The engineers have saved Tivoli, but its romantic beauty, as far as the river is concerned, is gone for ever.

The other engineering work which I mentioned, namely the canal from the Ombrone to the lake of Castiglione, has excited much interest. The lake of Castiglione, anciently the Lacus Prilis, falling very low in summer, left much marshy ground uncovered, in which were numerous stagnant pools, and quantities of putrid herbage, making the air poisonous in hot weather, and breeding myriads of noxious insects. To remedy these evils, Leopold 1st ordered the architect Ximenes to make a canal from the river Ombrone to the lake; by this means it was intended to keep the latter constantly at the same level. This work was finally executed by the present Grand Duke in the year 1830, and by means of a canal 7 miles long and 25 feet broad, a sufficiency of water is supplied to keep the lake at a proper level; so sufficient indeed was the supply, that the whole surrounding country was overflowed the first year; but this has been remedied. The air, it is said, has been improved; but when I visited Castiglione in 1832, I found that all who could, left it in the summer months, and all who remained had the fever. Some notice may be expected from one of the engineering works in the Pontine Marshes; but like other British travellers, I have only galloped through them, and have merely to state that the attempts to drain them cost a million of money.

The roads in the north of Italy are excellent, and indeed generally throughout the peninsula. Although a small portion comparatively of the country is intersected by roads, I have travelled many miles over turf, or by small tracks on the coast or on the mountains. Towns are almost universally built on eminences; consequently the roads are hilly, but I think less so than would be supposed from the nature of the country, and both in direction and in smoothness they greatly excel those of France.

The system of road making followed, is nearly the same as that adopted by the late Mr. Telford, that is to say, a pavement of stones is first formed, upon which the metal is laid;* but I do not think that the principles advocated by our great engineer are followed out in the formation of the pavement. Excellent roads, however, are the result of the system, even although gravel is used instead of broken metal.

Various principles of paving are now exciting much attention in London; it is to be regretted that something like a sensible principle is not followed in Edinburgh. In Italy various modes are adopted; in Genoa and at Naples large flat parallelograms of lava are used; at Florence, large irregular polygons carefully jointed; and at Rome, a pavement resembling our own, except that the stones are of regular forms, of one size, and grouted in with lime and pozzolana.

ANTHRACITE COAL FIELDS—THEIR OUTLETS, ETC.

Mr. Editor:—It may be interesting to many of your readers to know the extent of the Anthracite coal measures in acres. In preparing the following table, I have excluded all the conglomerate ridges which surround the different deposits of coal. Not being acquainted with the boundaries of the third great, or Wilkesbarre basin, and some of the small deposits north of Hazleton, I leave them to be supplied by others.

The first great, or Schuylkill coal basin, contains 67,000 acres, having the outlets to market as follows:

By the Lehigh canal,	*Acres,* 3,750
By the little Shuylkill railroad to Port Clinton, thence by Schuylkill canal or Reading railroad,	6,325
By Pottsville and Schuylkill Haven, thence by Schuylkill canal of Reading railroad,	31,875
A railroad six and a half miles in length will connect the Goodspring creek with the Mine Hill and Schuylkill Haven railroad, seven miles from Schuylkill Haven, and will make an outlet to market, either by the Schuylkill or by the Union canal, for	6,250

* I have not seen the railroad which has been lately made from Naples to Castellamare, but am well acquainted with the line; a novel question in engineering must arise in considering how it is to be protected from the lava of Vesuvius. This I believe will not be very difficult, but it has a more insidious enemy in the earthquake, and a more overwhelming one in the showers of scoriæ and ashes which accompany an eruption.

Railways may be useful in Italy to promote her commercial prosperity, but I pity the man who could think of travelling in such a manner through any part of that country.

By the Pinegrove, and thence by the Union canal,	13,500
By the Wisconisco railroad and canal,	5,800

The second great or Shamokin and Mahonoy coal field contains 59,450 acres, having the following outlets to market:

By the Lehigh canal, or by the Schuylkill, via the little Schuylkill,	4,700
By the Schuylkill, via the Danville and Pottsville railroad, or by the same railroad to Sunbury and the Susquehanna,	21,000
By the Danville and Pottsville railroad to Sunbury, (the Shamokin part of the basin,)	33,750
The Beaver Meadow coal basin,	11,350
The Hazleton basin,	12,500
Having their outlet to market by the Lehigh canal,	
The Broad Mountain coal basin, north of the Mine Hill, generally considered a part of the Schuylkill basin,	8,450
The Broad Mountain Summit basin,	2,225

Having their outlet to market by the Schuylkill, via Pottsville and Schuylkill Haven.

SAMUEL B. FISHER.

Pottsville, March 29, 1841.

From this communication, it appears that the above mentioned basins contain, in the aggregate, 155,220 acres of Anthracite coal lands, which have their natural outlets as follows:

By the Schuylkill, including the 6,220 acres on Good Spring creek,	72,225
By the Lehigh,	29,950
Shamokin, via Sunbury,	33,750
Pinegrove, by Union canal,	13,500
Wisconisc feoeder and railroad,	5,800
	155,220

Pottsville Miner's Journal.

DUTTON'S MODEL OF A BRIDGE.

MR. EDITOR:—Allow me, through the medium of your paper, to call the attention, particularly of the county commissioners and the beard of control, to two models of bridges, invented by our countryman and citizen, Mr. I. L. Dutton, No. 25 Pine street. The want of a bridge at Fairmount drew his attention to this subject, and either of these bridges is admirably adapted to that location. One of them is an improved suspension bridge; the other, on the principle of the patent lever self-sustaining arch. Yet both are constructed on an entirely new combination of principle, and for their great streagth and economy, are worthy the attention of the contractors, and the public generally, who are also secondarily interested. These models will be placed in the saloon of the Exchange on Thursday, where the public will have an opportunity of being gratified with a view of their symmetry and beauty.

There will also be exhibited, at the same time and place, an improved plan of a safety car, the invention of the same gentleman, and well worthy the inspection of the scientific, the railroad companies, and the public at large, all of whom are interested in any improvement that will secure safety to the traveller, and to the contractor economy, as it will cause at least one half less wear and friction than that constructed on the present plan.

A Friend to Public Improvement.

We have seen the model to which our correspondent refers, and trust that those interested in the erection of a bridge at Fairmount will make themselves acquainted with the principles of Mr. Dutton's invention, and ascertain its applicability to the circumstances of the site. It struck us that the plan was good, combining great strength with all convenience and means of ornament. Still, in so important a subject, it would be well that men skilled in mechanics should carefully examine the model, and as far as possible, test its worth. The model of the bridge for Fairmount is to a scale of half an inch to a foot, and, though constructed of light materials, is by their judicious combination, of great strength.

New Route.—The steamer Vermillion arrived at Buffalo a few days since, had among her large cargo, forty hogsheads of Ohio Tobacco destined for the Baltimore market. The Buffalo Journal says "it is a long journey, via Buffalo and the Erie Canal, yet the most speedy and economical route that can be obtained for produce that is seeking a market."

We lay items of this description before our readers to show the importance of our works of internal improvement. Our city is now the great shipping port for much the largest portion of our country, but it can only be so for a part of the year after the completion of the railroad from Albany to Boston, unless the New York and Albany and the New York and Erie railroads are constructed.—*Times and Star.*

A recent report to the Russian Government contains an account of the Chinese library, which forms part of the Asiatic Museum of the Imperial Academy of Sciences at St. Petersburg. This library was founded in 1730, at which period the Russian resident at the court of Pekin, sent by the emperor Peter I, transmitted several Chinese works. Since that period the collection has been constantly increased by contributions, either from envoys or by purchase; and a catalogue has been regularly made. The last addition was from the purchase of the rich collection of Chinese works of Baron Schilling de Canstadt, through the munificence of the Emperor. M. Brosset, the librarian, has lately classed all the works, and composed a new catalogue. This library, which is second only to that of Paris, contains 1,364 volumes bound, rnd 11,510 unbound. Among them are a general statistical account of China, in 300 unbound volumes, and a general history of the Chinese Empire, from the most remote period down to the present age.

Spots on the sun.—A correspondent of the Boston Daily Mail, says that "with one of my large diverging telescopes five distinct clusters of dark spots on the sun may now be seen, May 5th, the two clusters near the centre of the sun extend upwards of fifty thousand miles in length by about twenty thousand breadth; they will be visible a few days longer if the atmosphere is clear; the abve perhaps may account for the cold weather backward spring we have had. We do not know that any body in this part of the country has found an opportunity of looking at the sun long enough to ascertain whether it had spots upon it. Nor do we know that these spots would be a sufficient cause foa the cold weather of this spring. We remember however that in the year 1816, the summer was so wet and cold that corn unless in particular spots did not ripen; and then the spots on the sun ware so large that they were, toward sundown visible to the naked eye. *U. S. Gaz.*

AMERICAN
RAILROAD JOURNAL,
AND
MECHANICS' MAGAZINE.

No. 11, Vol. VI.
New Series. | JUNE 1, 1841. | Whole No. 383.
Vol. XII.

BLASTING ROCKS.

We meet almost every day, with some fearful account resembling this:

FATAL ACCIDENT.—On the 8th inst., a young man named Henry Jenkins, at Glen's Falls, Warren county, while blasting rocks for the purpose of procuring iron ore, was fatally injured by the premature explosion, of the charge. The tamping iron was driven completely through the right portion of his head, carrying away in its course a large portion of the skull and brain. He lingered in terrible agony for nearly twenty-four hours.

Who would think, after reading such a paragraph, that *all* risk of such an accident might be dispensed with, and at the same time great economy be attained? Such is the fact, and although the proper use of precautions has enabled immense works to be executed without a single accident, it is almost impossible to *compel* workmen to adopt any improvement. It is well known that when copper needles were first used, as instead of iron ones, as being less hazardous, the workmen were in the habit of throwing away the copper needles, when furnished them, and of using the old iron instrument.

The philosophy of blasting is quite deserving of study, as immense sums of money are yearly expended for gun powder, and it is worth while ascertaining whether the maximum effort is attained for the weight of powder used, and what is still more important, whether the minimum has been attained in the yearly loss of life.

A wire suspension bridge is to be built over the Schuylkill at the Fairmount Water Works, Philadelphia. Mr. Ellet, engineer, is the contractor. It is to be finished by January next.—*N. Y. Standard.*

It is seldom that so short a paragraph has given us so much pleasure. The causes which have delayed the action of the proper authorities are unknown to us—but now we hope no further impediment will interfere with the immediate execution of the work. Mr. Ellet has always had our best wishes and hopes in his efforts to introduce this beautiful and economical style of bridge building. We want but one fair specimen to lead the way for hundreds of others,—we say hundreds, for we have no doubt that there are hundreds of locations where circumstances would indicate the propriety of erecting suspension bridges. The specimen we are about to have, will no doubt, do credit alike to the city of Philadelphia and the contractor.

PUBLIC IMPROVEMENT IN CANADA.

Lord Sydenham, the new Governor General of Canada, at the opening of the United Parliament, holds the following language in regard to public works:

Many subjects of deep importance to the future welfare of the Province demand your early attention, upon some of which, I have directed bills to be prepared, which will be submitted for your consideration.

Among them, first in importance at the present juncture of affairs, is the adoption of measures for developing the resources of the Province, by well considered and extensive public works. The rapid settlement of the country—the value of every man's property within it—the advancement of the future fortunes, are deeply affected by this question.

The improvement of the navigation from the shores of lake Erie and lake Huron to the ocean—the establishment of new internal communications in the inland districts, are works requiring a great outlay, but promising commensurate returns. To undertake them successfully, large funds will undoubtedly be required, and the financial condition of the Province, as it stands at present, would seem to forbid the attempt. But I have the satisfaction of informing you, that I have received the authority from her Majesty's government to state, that they are prepared to call on the Imperial Parliament to afford their assistance towards these important undertakings. In the full belief that peace and tranquility will be happily re-established in this Province, under the constitution settled by Parliament, and that nothing but a relief from its most pressing difficulties is wanting to its rapid advancement to prosperity, they will propose to Parliament, by affording the guarantee of the Imperial Treasury for a loan to the extent of no less than a million and a half sterling, to aid the Province for the double purpose of diminishing the pressure of the interest on the public debt, and of enabling it to proceed with those great public undertakings, whose progress during the last few years has been arrested by the financial difficulties. I shall direct a measure to be submitted to you embracing a plan for this purpose, and I shall lay before you, for your information, and that of the people of Canada, extracts from the despatches which convey to me this most gratifying assurance.

THREE GREAT RAILWAY ROUTES FROM NEW YORK CITY TO LAKE ERIE.

We resume our remarks upon the second of these routes, the New York and Erie road, where the same were discontinued in a previous number, viz. at that period in its history, when by an act of the legislature, it was authorised to use the credit of the State in aid of its construction to the amount of three millions of dollars. This act was passed during the session of 1836, and encouraged the company to prosecute the work with renewed energy—accordingly the Engineer department was reorganized in the spring of that year, by the appointment of E. F. Johnson, Esq., and Capt. Talcott; to the former of whom was assigned the charge of the eastern division of the road, extending as far west as Painted Post, 314 miles, and to the latter, the western division, embracing the remainder of the distance to lake Erie, 170 miles. Under this arrangement, the services of Judge Wright were continued as consulting engineer.

The examinations, which had been some time in progress, were continued by these gentlemen, with a view to a definitive location of the road, and at the close of the season, Mr. Johnson made a report in detail of so much of his division as lay between the Hudson river and the Shawangunk ridge, a distance of about 60 miles. A similar report, was also made by the engineer of the western division of the portion of the road nearest to lake Erie.

The views of Mr. Johnson, relative to the most suitable location for the eastern division of the road, differed in many respects, from those previously given by Judge Wright. The reports upon this subject, have never been presented to the public. It is proper here to state, that the opinions of the former gentleman were approved by the then Board of Directors.

Mr. Johnson, in his examinations in Sullivan county, west of the Shawangunk ridge, became satisfied of the impropriety of attempting to carry the road through the interior of this county, as recommended by Judge Wright, in preference to following the valley of the Delaware river; thus increasing the total rise and fall full 1600 feet, without any probable saving in distance or expense. He accordingly caused examinations to be made upon the only questionable portion of the route, leading from the Shawangunk ridge to Carpenter's Point, on the Delaware, which showed, that by adopting that route, the advantages above enumerated would be attained, and in addition thereto, the tunnel at the ridge be avoided

—the maximum grade of 90 feet per mile, reduced to 50 or 55 ft., and the line placed in a position to develope much more completely the resources of the country, and thus secure to the road, ultimately, the greatest amount of business.

Mr. Johnson also became satisfied, from examinations made between the Delaware river and Binghamton, that the route which had been selected ought not, under any circumstances, to be adopted, being clearly of opinion that the road should be carried by the way of the great bend of the Susquehanna, thus lessening, very materially, the distance, the expense, and acclivity and extent of the maximum grades, and diminishing the aggregate rise and fall, about 1100 feet.

Mr. Johnson also invited the attention of the company to the subject of the best width of track for the railroad, and gave some reasons for exceeding the width previously adopted, and with reference to which the grading which was then in progress on the Delaware, was being executed.

In the spring of 1837, the great revulsion took place in the monetary affairs of the country, and the New York and Erie Company, like many others, deemed it necessary to suspend operations. They accordingly disbanded their engineer corps, and effected a settlement with the contractors, who were then engaged in the grading of forty miles of the road along the Delaware river, being the only portion of the road which, up to that time, had been under contract, and which was then about two-thirds completed.

In effecting this settlement, large advances, it is understood, were made by the house to which the president of the company, Jas. G. King, Esq., was attached—whereby the engagements of the company were fully meet, and its credit sustained.

Although the construction of the road was thus discontinued, the friends of the enterprise did not relax their efforts in its behalf. The subject was discussed in the public journals, and meetings held in various places. A general convention was also held at Elmira, at which the present Governor of the State, was chairman of a committee to prepare an address to the public, setting forth the great merits and importance of the work.

During the session of the legislature in 1838, a report was made by engineer Johnson, in which the general subject of railways was fully discussed—the principles of their operation investigated, and applied to the case of the New York and Erie railroad. This report, was published by the legislature, in connection with one from a committee of that body, and an act was soon after passed, altering the conditions upon which the loan of three millions of dollars was to be made available to the company, the new conditions requiring that the company should first put under contract ten miles at each end of the road, after which they were to receive from the State the loan of $3,000,000, in sums of $100,000 each, the payments to be made whenever a like amount should be raised from the stockholders, and expended upon the road.

In the spring of this year, the company, in order to avail themselves of the provisions of this act, appointed resident engineers to superintend the ten miles which was first to be put under contract, at each extremity of the road. Surveys were also made during the season on the middle or Susquehanna division, with a view to the location of that part of the road.

By request of the commissioner, engineer Johnson visited Dunkirk, and after examining the ground in that vicinity, suggested a change in the location of the road from the lake to the summit, which, it was found, would reduce the cost of construction, and lessen the maximum grade from 70 to 60 feet per mile. This change he recommended from a conviction of the impolicy of exceeding 60 feet per mile, when it could possibly be avoided, with a view to ensure certainty and safety, and the most economical use of the locomotive power, and also on account of his conviction, from a full knowledge of all the ground, that if the best route was selected for the road, there would be no occasion for exceeding the maximum of 60 feet in the grades of any other portion of the line.

The surveys and examinations were continued under the general supervision of the agent of the company, throughout this, and the following season, and portions of the line were put under contract. Upon one portion, the Susquehanna division, embracing a distance of 117 miles, the plan of founding the road upon piles, has been adopted, under circumstances which will probably enhance very much the cost of the road, beyond what it would have been, had it been graded in the usual way.

During this period, Eleazar Lord, Esq., of Tappan, was elected to the presidency of the company.

In the session of 1840, the legislature made a further change in the conditions of the loan, previously authorised, by allowing the company two dollars for every dollar raised from the stockholders and expended upon the road.

This gave a new impetus to the action of the company, and during the year nearly the whole of the remaining portion of the road was put under contract, the conditions of the contracts requiring the contractors to receive pay in the stock of the company, to the extent of one-third or three-eighths of the amount of their contracts.

Toward the close of the year, the company, it is said, appointed a chief engineer. We have seen no public announcement of this fact, and the report of the president and directors of the company, to the stockholders, recently published, is silent upon the subject. This report, which was issued in February last, is entitled, the *second* Report, and appears after an interval of more than five years from the date of the first.

Our comments upon it will be deferred to the next number.

NOTES ON THE STEAM NAVIGATION UPON THE GREAT NORTHERN LAKES.—*By L. Klein,* Civil Engineer.

Continued from page 302.

The communication between the extreme ports of the upper lakes, between Buffalo and Chicago, is maintained by steamboats of the largest class; of which, in 1839, the "Illinois" and "Great Western," were the most prominent and favored. Often passengers would prefer to wait several days at Buffalo, Detroit, or Chicago, in order to take passage in one of these two steamers. The "Great Western," was unfortunately destroyed by fire at Detroit, on the 1st of September, 1839. She was built differently from the other lake boats, and more resembling the steamers of the western rivers. The room below deck was used exclusively for freight; the machinery, ladies' cabin, and deck passengers' cabin, were upon the lower; the gentlemen's cabin and state rooms, upon the upper deck. She was of 800 tons burden, and cost $100,000.

The "Illinois," is regarded as the best finished, and largest boat, upon the lakes. Her cost was $120,000, including the engine, for which $45,000 were paid. She is likewise a new boat, having made in 1838, only a single trip. The dimensions are given in page 238. The diameter of the cylinder of the steam engine is 56 inches, the stroke, 10 feet.

The time allowed for each trip from Buffalo to Chicago, and back, is 16 days, and the distance between the two cities, in the line the boats are now running, is 1000 miles. The "Illinois," generally, requires for a passage up, (to Chicago,) 5 days, and for a passage down, (to Buffalo,) 4 days. This is at the rate of 250 miles per day, or 11 milles per hour, including stoppages. If for the latter, 12 hours are deducted, there remains for 1000 miles, only 84 hours, corresponding to an average speed of 12 miles per hour.

A cabin passenger, pays for a passage between Buffalo and Chicago, $20; a deck passenger, pays only $10; the fare between Detroit and Chicago is, for a cabin passage, $16; for a deck passage, $8. The charges for freight, are: for heavy goods, 62½ cents, per cwt.; for light goods, $87\frac{1}{2}$ cents, per cwt. A cabin passenger, pays, therefore, 2 cents per mile, including board; a deck passenger, 1 cent. per mile; and the charges for freight, are on an average, between heavy and light goods, at the rate of $1\frac{1}{2}$ cents per ton, per mile.

Up to August, 1839, (when these notes were collected,) the "Illinois" had made seven circular trips between Buffalo and Chicago, and earned, at an average per trip, (of 2000 miles,) $5000. Two-thirds of the receipts were from passengers, and one-third for freight. This income appears very great, but it may be remarked here, that a great deal more has often been earned by a steamboat on a single voyage to Chicago, and back. In 1836, the then largest steamer of the lakes, the "Michigan," brought in one voyage, over $14,000. Less popular boats, have on the contrary, a far smaller income than the "Illinois," and also derive the same, nearly one-half from passengers, and one-half from freight.

The expenses of running the "Illinois," were stated to be per trip, (of 2000 miles,) $2,600, or rather more than one-half of the gross receipts. The largest item, is the cost of fuel; the consumption being 500 cords of wood, at $2, per cord. The salaries of captain and crew, which latter consists of not less than 40 individuals, also constitute a heavy item in the expense of running the boat. To the $2,600, we must again add the proper sum for general depreciation, amounting, per annum, to $\frac{120,000}{10} = \$12,000$. If 13 trips are made by the boat per year, the depreciation per trip will be $\frac{12,000}{13} = \$923$, and this added to the above $2,600, gives $3,523, as the total expense of running the "Illinois" 2000 miles, equal to $\frac{3523}{2000} = \$1\ 76$ per mile of travel.

The boarding of 60 passengers, (about the average number per trip,) during nine or ten days, may be calculated to cost about $423 dollars, and the actual cost of running the boat 2000 miles, is therefore $3,100, being per mile of travel, $\frac{3100}{2000} = \$1\ 55$.

The nett income per trip, was $5000—3523 = \$1477$; for the whole year, if 13 trips were made, $1477 \times 13 = \$19,201$, which is 16 per cent. of the capital invested.

The smallest of the steamers, which make regular passages between Buffalo and Chicago, is the "United States," of 367 tons burden. She has a high-pressure engine, with a 28 inch cylinder, and 7 feet stroke, built at Pittsburg, similar to those used for the boats upon the Ohio and Mississippi. The "United States" travels much slower than the other boats, and is therefore chiefly used for the freight business. She requires six days for a trip from Buffalo to Chicago, and generally goes at the rate of 7 miles per hour. The captain of this boat stated, that the average daily current expenses, amount to $120, when the boat is running, and to $40, when she is at rest. This would make, for a trip to Chicago and back:

12 days, (running) at - - - - -	$120	$1440
4 days, (resting) at - - - - -	40	160
Total, per trip, - - -		$1600

The expenses, per mile of travel, are, therefore, only $\frac{1600 \times 100}{2000} =$ 80 cents; comprising, however, nothing for general depreciation: and including the expenses of boarding the cabin passengers. As both will amount to about the same per trip, the 80 cents may be considered as the actual cost of running the "United States" one mile.

According to the above calculation, whe have:

Name of steamer.	*Tonnage.*	*Expense per mile of travel.*	*Expense per ton burden per mile.*
Illinois,	800	155 cents	0.194 cents.
Erie,	500	111 "	0.222 "
United States,	367	80 "	0.218 "
	1667	346 cents.	0.208 cents.

It therefore appears that the cost of running steamboats upon the lakes, was, in 1839, near *one-fifth of a cent. per ton burden per mile.* It would, however, be necessary to have similar data from a greater number of steamboats, to obtain more correct and more general results in this respect. It may be presumed that steamboats of a small tonnage are more expensive to run, and that the above result will only be found true between certain limits,* say with boats of 300 to 800 tons burden; provided, at the same time, that the power of the engine is always proportioned to the tonnage of the vessel.

Most of the large steamers upon the upper lakes, were built in 1837 and 1838, probably in consequence of the unusual increase of business in 1836, and it having been ascertained, that with a moderate traffic, a good profit may be realized from the running of steamboats. But as the number of steamers had increased faster than the traffic, the latter was not sufficient in 1838, to occupy all

*And also for routes of great length.—*Ed.*

of them. This gave rise to a great competition, and in consequence, to a reduction of prices for passage and transportation, below the amount required to defray the expenses of running. Thus, for instance, the boats took cabin passengers from Buffalo to Detroit for $4, including board, which is at the rate 1 1-9 cent. per mile; and in the same proportion, the charges for freight had gone down. In order to obviate, for the future, a similar state of things, attended by a general loss to all the steamboat proprietors, an association was formed on the 1st of June, 1839, by the owners of thirty steamboats, the object of which was: to establish regular lines of steamboats between Buffalo, Detroit, and Chicago; to employ for this purpose, as many boats as may be required to accommodate the existing travel and freight business, and to lay by the remainder; finally, to fix a regular tariff for the conveyance of passengers and freight, to which all the steamboat proprietors, forming the association, shall be bound, and which would be high enough to insure a good profit.

As it may be of interest to know the principles and engagements upon which this association was founded, I give the following brief extract of the principal paragraphs of the agreement:

1st. The affairs of the Association are conducted by a board of directors, residing at Buffalo, who superintend the whole operations, fix the number of trips, the times of departure, number of boats to be employed, from time to time, etc. At all the other ports, agents are appointed, who have to watch the interest of the association.

2d. Each steamboat represents a certain number of shares, proportioned to its actual value. The steamboat "Illinois" was put down with the largest number of shares, viz. 80; then followed the "Great Western," with 70, the "Buffalo" with 70, the "Erie" with 68, etc., etc. With the smallest number of shares, are noted the "Pennsylvania," (with 38,) the "Lexington," (37,) "Monroe," (33,) "Charles Townsend," (27).

3d. The directors have to arrange it so that all the boats belonging to the association, are as much as possible, equally occupied; and the owners have, on their part, to see that the respective boats are ready for starting, when it is their turn. If a boat misses a trip, her owner has to pay ten dollars per share, (or is charged that amount,) if the destination is Detroit, and a greater amount in proportion to the distance, if her destination was Chicago.

4th. Each proprietor defrays all expenses of running his boat, as formerly. Of the gross receipts from each voyage, 15 per cent.

are to be paid into the general fund, on the arrival of the boat at Buffalo; for the remainder, the owner of the boat is charged in the books of the association; the captain, having always to deliver a copy of his way-bill to the directors, on finishing his trip. At the end of every month, the accounts are settled; the whole gross income (after deducting the 15 per cent. paid into the general fund for the general expenses of the association,) is divided among the owners of the boats, accordlng to their respective number of shares. Those who had a greater income than they are entitled to, have to pay over the surplus, which is received by those whose income fell short of the amount, corresponding to their number of shares.

5th. For the boats going to Chicago, a deduction of 5 per cent. of the gross income is allowed to the owners, on account of the greater risk; after paying 15 per cent. to the general fund, they are charged only with 80 per cent. of the gross receipts.

6th. If 15 per cent. of the gross income should not be found sufficient to cover all the general expenses of the association, the steamboat proprietors have to supply the defficiency, by paying a certain amount for each share. The directors may fix penalties for non-compliance with the provisions of this agreement, and are authorized to receive new parties, as members of the association.

This agreement resembles, in many regards, the one which was made in 1838, among the several transportation companies, owning lines of canal boats upon the Erie canal; with the difference, that the latter divide the *nett profit*, according to the number of shares assigned to each party; while the proprietors of the steamboats divide the *gross receipts*. Both associations have attained their object; which is, to prevent opposition and its injurious effects, for the pecuniary interests of the boat proprietors. The public, on the contrary, must be losing for the same reason; as canal and steam navigation are thereby made a monopoly, like the transportation upon railroads.

In the summer of 3839, in consequence of the arrangements made by the board of directors of the association, two boats started daily from Buffalo for Detroit, one in the morning, and one in the evening; the one being intended principally for carrying freight, the other for passengers, although both were receiving freight and passengers at the same rates. Every second evening the boat which left Buffalo for Detroit, was also to continue its passage to Chicago. As formerly mentioned, the time allowed for a trip to Detroit, and back, was six days; and for a trip to Chicago and back, 16 days; the number of boats required for the trade between Buffalo and Detroit, was, therefore, 6 × 1 1-2 = 9; and between Buffalo and Chicago, 16 × 1-2 = 8; total number, 17; this shows, that of the 30 steamboats belonging to the association, only 17 were regularly employed, while 13 remained in the ports; and as the profits were divided among all, they will hardly have amounted to more than 8 per cent. of the cost of the steamboats.

The expenses of running a *canal boat* of about 60 tons burden, are, upon the Erie canal, as well as upon the Ohio canal, very near 40 cents per mile, *exclusive* of tolls; these 40 cents comprise the cost of traction, the salaries of captain and crew, the repairs and depreciation, and all other incidental expenses. We have seen that the expenses of the steamboat "Illinois," are 150 cents, of the "Erie," 111 cents, and of the "United States," 80 cents per mile of travel; the cost of running a steamboat upon the lakes, is, therefore, according to its size, only from two to four times as great, as that of running a canal boat. If we take into account also, the *toll* paid on canals, and which amounts to about 30 cents per mile, if the boat be loaded with 25 to 30 tons only, we see that it will not be more expensive to run a steamboat of 300 tons burden upon the lakes, than to run a canal boat upon either the Erie or the Ohio canal.

In regard to *railroads*, experience has shown that the expenses of working them average about one dollar per mile per train. The same expenses are increased by running a steamboat of 400 to 500 tons burden upon the lakes. Such a steamboat generally takes a greater load than a railroad train, and at the same time, as the capital invested in steamboats is comparatively small, a small surplus of receipts over the expenditure will suffice to pay a good interest; while the railroads in the United States require the gross income to be twice as great as the expenditure, in order to yield a handsome dividend. If, therefore, railroad lines and steamboat routes, are of the same length, the transportation by steamboats will be cheaper than by railroads.

The *Ohio railroad*, for instance, located along the southern shore of lake Erie, and now in progress of construction, will, during the season of navigation, hardly be able to compete with the steam navigation upon lake Erie. But the railroads projected in Michigan and Ohio, to connect lakes Erie and Michigan, will be at least three times shorter than the steamboat route over lakes St. Clair, Huron, und Michigan, and the transportation upon them, will therefore, be cheaper than by steamboats; the more so, as goods are nearly always insured, if forwarded by the latter. Passengers will generally prefer to travel by railroads, even at a higher fare, on account of their being more safe and expeditious than steamboats.

U. S. ENGINEER DEPARTMENT AND PUBLIC DEFENCE.

The following extracts from the report of the Secretary of War, will be found to contain such portions of that document as are calculated to interest our readers, in professional matters :

The many weighty considerations which invite the immediate attention of Congress to the subject of the public defences generally, and particularly to the works absolutely necessary to the security of our great commercial emporiums, and the keys to our most valuable resources of every kind, must be so generally understood and appreciated that nothing this Department can urge could add any thing to their force and conclusiveness. To say nothing of the destruction of property, and our weakened condition in a military point of view, attendant upon the carrying of any of our most assailable points, the penetration of our territory and the seizure of even one of our strongholds by a powerful enemy upon the sudden outbreak of war, it would seem to be equally the dictate of patriotism and wisdom to make due provision against the infliction of such insults to the national honor and character.

It has been urged as an objection to the further progress of the works heretofore projected for the defence of our extensive sea coast, that the recent experiments in the use of steam power in ocean navigation, and the ready application of the same powerful agent to the defence of our principal harbors, together with the late inventions in the means of increasing the destructiveness of shells, must soon introduce an entire change in the system of coast defence, as well as of maritime war in general. It is true that the mental activity, characteristic of the age in every other art and science, has not been less fruitful in suggesting improvements in the art of war, the value of some of which has already been tested in practice, and doubtless others will, in time, prove equally successful. In no department of public affairs may the natural connection and dependence between all the sciences and inventions of art be more beneficially illustrated than in the improvement of the means of national defence. That the cause of humanity will be promoted in proportion as the existing systems and means of defensive warfare are perfected by new improvements, in affording to all nations greater security to the independent enjoyment of their own acquisitions and forms of society and government; in putting the weak upon a more equal footing with the strong; in rendering wars less frequent, and allowing all the arts of peace to flourish in uninterrupted vigor, cannot be doubted. It is a source of much gratification to observe that several gentlemen of high professional distinction in the army are employing themselves in these appropriate studies. But while, in carrying forward the plans devised in former years, due regard should be had to the improvements already introduced in the means of defence, and, as far as practicable, to such modifications as may be rendered necessary by future discoveries, we must take care, by the most efficient application of the means already known and approved, not to lose the advantage of present security.

The array of well-authenticated facts and results of past experience, and the well sustained reasoning founded upon them, exhibited in the report of the board of officers referred to in the accompanying letter of the Chief of the Corps of Engineers, appear to be conclusive in favor of completing the system of defence therein recommended, so far, at least, as to place the country in what is denominated a *good* state of defensive preparation against any sudden occurrence of war. To this extent the completion of the works heretofore projected may be regarded as indispensable, however defective they may be as a perfect system of national defence. It will be seen from the estimates stated in the report alluded to, that to effect that object will require an appropriation of $9,793,547 upon the fortifications, $2,493,000 for the armaments; making together the sum of $12,186,547. The obligation of the government to apply this sum to the objects contemplated as speedily as the nature and due permanence of the several constructions will admit, is rendered imperative and absolute by every consideration of public safety and public honor.

It is estimated by the chief engineer that the sum of $1,435,500 can be judiciously and most beneficially applied upon these essential works of defence during the remainder of the present year, in addition to the appropriations heretofore made for the same objects. The expenditures in this branch of the service have been more considerable in the current quarter than usual, and hence the additional appropriations asked for are larger than they would have been under ordinary circumstances. How this has happened will be explained by the fact, that soon after the accession of your immediate and lamented predecessor, all the means at the disposal of this department were directed to be employod upon the fortifications and other works for the protection ot the Atlantic frontier, in the manner deemed best ealculated to produce the greatest possible effictency in the shortest time. This course appeared to be called for by the unsettled and threatening aspect of our foreign relations. While the whole of the resonrces at the disposal of this department for this service were thus ordered to be applied to such unfinished works as could be made available, in whole or in part, in a reasonable time, it is proper to state, in this connection, that directions were at the same time given to supply, without delay, the works already completed with their appropriate armament.

The promptitude and liberality with which the Governor of New York and the commissioner of public lands in that State, responded to the recent application of the department to be put in possession of the works constructed on Staten Island, under the supervision and at the expense of that State, for the defence of New York harbor, deserve the thanks of the country, and should be further acknowledged by the immediate appropriation of the sum demanded as a compensation for the ground upon which they are situated. The works are regarded as of great importance to the object for which they were designed, and they are now in a course of repair and improvement, under the direction of a competent officer of the corps of engineers. The correspondence between this department and the Governor of New York, and the rport of the chief engineer, will show the terms upon which the title to this property will be vested in the United States.

* * * * * * *

The subject of the expediency of completing the Cumberland road, and of improving certain harbors, and the navigation of certain great rivers, which may be regarded as necessary and proper, in making adequate provision for the public defence, I propose to postpone the further notice of until the stated session of Congress, as the consideration of it will involve the propriety of making appropriations for various works of internal improvement not necessarily connected with that object, and, consequently, will require more time than Congress, at its approaching session, may find it convenient to give.

At the last session of Congress, the sum of $30,000 was appropriated to be expended, under the direction of this department, in repairing the breach in the Potomac bridge. Soon after the adjournment, an officer of the Corps of Topographical Engineers, distinguished alike for his science and practical skill, was selected to make the necessary examinations, and to report a suitable plan for the execution of the work. With what skill and accuracy he has performed this preliminary service, will appear from his report to the chief of the corps. The highest confidence being reposed in the soundness of his judgment, it was determined at once to expend no portion of the money placed at the disposal of the department for the accomplishment of so important a work upon a plan which did not promise to secure, what was held to be indispensable, its permanence and durability. From the statements contained in the report of Major Turnbull, it is obvious that the repairs, if done upon the plan which formed the basis of the estimate upon which the appropriation was made, could not stand through a single season of freshet or ice. The question was then presented, whether it was proper to commence the repairs upon the only plan which promised the requisite strength and durability, but the cost of which would far exceed the appropriation made by congress, and which, it was known to the department was supposed to be ample for the object, or wait the sanction of that body at the approaching session. The great convenience and importance of the bridge at this point, and the strong interest felt by the citizens of this district that the repairs should not be delayed, urged the immediate commencement of the work, while its questionable propriety, under the prospect of an immediate session of congress, decided the department to postpone further operations until that body should have an opportunity of acting upon the subject. The utility and importance of this bridge, not only to the citizens of this city and district, but to the carrying of the public mail, and to the southern travel at the season of the year when the river is obstructed by ice, are so generally felt and acknowleged, that I need say no more to recommend the additional appropriation required; or that the sanction of congress be given in some other form, at an early day of the session, to the making of the necessary repairs upon the only safe and durable plan which presents itself.

Another public work of great interest committed to the care of this department, deserves some notice at this time. The sum of $75,000 was appropriated at the late session of congress for clearing out the Red river raft. The large sums of money heretofore expended on this object, the high expectation indulged, after the first successful experiment, of the practicability of effecting it, the subsequent accumulation and continuance of partial obstructions, and the consequent disappointment of the public, caused the department to give its early and serious attention to the subject. Believing that congress, in making this appropriation, indulged the hope that it would be all that would be required for the completion of the work, the department, resolved that the highest degree of permanence and utility attainable by the use of the means placed at its disposal should be accomplished, directed that an officer of the highest credit for skill and judgment should proceed without delay to ascertain the nature, extent, and causes of the obstructions which interrupt the navigation of that river, and to submit a plan for their removal. That officer has not yet reported to the department. It is intended that the steam and snag boats, after being repaired, shall ascend Red river, while it continues in a navigable state, to the point of obstruction; but it is not designed to enter upon the work until autumn. This policy, as will fully appear from the report of the chief, of the Topographical Engineers, and the accompanying letter of the superintendent, was dictated by a sound economy, if not by the necessity of the case.

REPORT OF THE ENGINEER IN CHIEF OF THE GEORGIA RAILROAD AND BANKING COMPANY TO THE CONVENTION OF STOCKHOLDERS, MAY 10, 1840.

To WILLIAM DEARING, Esq., President:

Sir.—The preliminary location of the extension of the Georgia Railroad above Madison, in progress at the date of my last annual report, was completed during the summer anb an estimate of its cost in detail furnished to the Board, from which the following synopsis is taken:

Grading and Bridging, - - - -	$581,191 80
Iron Rails and Fixtures, - - - - -	363,900 00
Laying Superstructure and furnishing Cross Ties and Sills	161,000 00
Engineering, Rights of Way, Depots and unforseen contingencies, - - - - - -	109,000 00
	$1,215,091 80

The length of this extension is 67½ miles making the whole dislance from Agusta to the terminus of the Western and Atlantic Railroad 172 miles which may probably be reduced on the final location near two miles. The route traced after leaving Madison, follows the ridge separating the waters of the Apalachee and Little Rivers to the Social Circle, whence it descends to the Alcovy River, at Colley's Bridge, it at an elevation of 70 feet, and then takes nearly a direct course to Covington, where it bends Noth West, and intersecting Yellow River a short distance adove the Decatur Road, it gradually rises to the ridge parting Yellow and Ocmulgee Rivers, which it follows leaving the Stone Mountain 1¼ miles to the right until it joins the high grounds dividing the latter from the Chatahoochee. Along these it is continued to the terminus of the Western and Atlantic Railroad, touching the South East angle of the village of Decatur. The steepest gradient upon the whole line is 7-10 *ft* per 100 feet, and radius of shortest curvature 1910 feet.

The heavy portions of the work upon this extension, to which I called your attention in my report of 1839, has in the route adopted, been partailly avoided, which will render the period necessary for its graduation less than then anticipated. Still however, the work is of that character and magnitude that it can only be accomplished economically by the expenditure of much time. The heavy work referred to is embraced within a space of 13 miles, extending from one mile East of the Alcovy to three miles West of Yellow River, and will cost for the graduation including bridges $251,000 00, leaving but $330,091 80 for the graduation of the remaining 54½ miles. About one fourth of the work upon these 13 miles, is comparatively light, and might be let at a later period than the rest; which would leave $138,000 00 as the immediate obligations, necessary to contract to prosecute the work upon the plan that I have advised in previous communications.

The importance of completing this link—connecting us as it will with a Railroad now nearly finished, extending to the navigation of the Great Western waters, at the earliest possible period and the disastrous consequences which will follow any considerable delay in its execution, must be so apparent to every stockholder in our enterprise, that I forbear to press the subject again upon their attention.

The Road is now in operation to Madison, a distance of 104 miles from Augusta. The causes which have delayed its completion to that point it may not be inappropriate to refer to at the present time. Iron sufficient for the whole Branch was ordered at an early date but in consequence of the high price offered for labor on ther Western and Atlantic Railroad, our heaviest sections of graduation, lying between this place and the Oconee River (upon which white hands were chiefly employed) became almost deserted, and all the efforts of the contractors to replenish their force to the desired number, proved unavailing. The progress of the work being thus retarded, it was deemed prudent to suspend for a time the order for Iron for that part of the Branch, beyond Greensboro. Early information of the condition of the work, and the necessity for a renewal of the order, was given by this department, but from causes, I believe, growing out of the deranged state of the currency, at the time,—it was deferred until too late for the Iron to be received at Savannah, before the fall in the river prevented its immediate transportation to Augusta, and the unprecedented continuance of dry, weather, during the summer and entire fall of 1839 afforded no opportunity, for its delivery until late in December following, the work was then pushed with a view to its completion to a point near Maison in season for the crop of last fall. The great freshet in may however, which swept away 450 feet of our embankment upon the low grounds of the Oconee, averaging 24 feet in height, and a temporary truss bridge 200 feet in lenth, interposed another obstacle to the accomplishment of our wishes. This c aused a delay of near two months, and in consequence I determined to place the terminus of the Road for the business operations of the season, at Buck Head; a place of easy access from the various sections of the country from whence we derive our custom. From Buck Head the work progressed steadily, opening in season for the spring business at Madison.

The great May freshet in the Oconee, attained a height unknown to that river, raising 13 feet above what had been pointed out to me as high water mark. At its greatest elevation it stood midway between the roofed floor and the bottom chords of the bridge, placing the structure in eminent peril. The waters, however, finally subsided without causing other injury to the bridge than displacing a portion of the rock work of the western abutment, allowing that end of the superstructure to be moved a few feet out of line; which was readily brought back to its place by the aid of large screws, kindly loaned to us by the President of the South Carolina canal and railroad company.

The grading of the Athens Branch is now finished, and the superstructure is progressing at a rate that will insure its completion during the present year, though its execution is attended, in consequence of the necessity of procuring the chief part of the materials from the piny woods, (a distance of from 70 to 90 miles,) with much trouble and vexation.

The cost of the unfinished work, and that for which estimates have not been returned, on both branches, including depots, and additional machinery for the whole road yet to be furnished, is estimated at $92,000.

The length of the road now in use is over 120 miles, and in the space of two months it will be extended to 133 miles. The Athens branch then terminating at or near the Lexington and Athens road, where the business will be centured during the next fall.

Concluded in next number.

Railroads in England.—A return of the passengers and receipts on the railways in England and Scotland, 29 in number, for one week in May, gives the number of 222,210 passengers, and an income from passengers and transportation of merchandize of 61,850*l*, or $296,880.

ABSTRACT OF A LETTER TO BARON A. HUMBOLDT, UPON THE INVENTION OF THE MARINER'S COMPASS.—LETTRE A M. LE BARON A. DE HUMBOLDT, SUR L'INVENTION DE GA BOUSSOLE; PAR M. J. KLAPROTH. PARIS, 1834, PP. 138.

Read before the Connecticut Academy of Arts and Sciences, by EDWARD E. SALISBURY, A. M., and published by permission of the Academy.

This is the title of a little volume, published six years ago, in which M. Klaproth, a well known orientalist, since deceased,* has given the result of researches made by him, respecting the invention of the mariner's compass.

It has been long since generally admitted, that the classic writers, though they had some idea of the attracting and propelling power of the magnet, were ignorant of its polarity, and consequently of its applicability to navigation. But the latter opinion, that the merit of this discovery is to be attributed to an Italian of the middle age, must be also abandoned. Klaproth's investigations go to prove, that our knowledge of the magnet, as well as of the magnetic needle and compass, has been derived, either directly or indirectly, from the east, and originally from China, where the earliest notices of both belong.

Should this work not have become known already in this country, a brief abstract of its most important points may not be unentertaining or without value.

The name *magnet* comes from the Greek. The most ancient Greek name for this natural production was (*Lithos herakleia,*) *stone of Heraclea*, a city situated at the foot of Mt. Sipylus, in Lydia. This city was afterwards called Magnesia, and the name of the stone, for which it was remarkable, became changed to (*Magnesios Lithos,*) *stone of Magnesia*, or vulgarly, (*Magnes,*) and (*Magnetes.*) The same name is found in the Latin, and its origin from the Greek is confirmed by Lucretius, who says:

> "Quem magneta vocant patrio de nomine Graii:
> Magnetum, qua sit patris in montibus ortus."

Other languages into which the name *magnet* has been incorporated, are the modern Greek, (*Magnetes,*) the German, (*magnet,*) the Hollandish, (*magneet-stein,*) the Danish, (*magneet,*) the Swedish, (*magnet,*) the language of the Grisons, in the dialect of Surselva, (*magnet,*) the Hungarian, (*magnet-ko,*) the Russian, (*magnet,*) the Polish, (*magnes, magnet,* and *magnet-kamien,*) and the Vendish of Styria, (*magnet,*) where, excepting in the modern Greek, the Latin has unquestionably been the medium of transporting the word from the ancient Greek.

Another name in use in several European idioms, as in the Greek, Italian, French, the romance language of Surset, the Bosnian, Croatian, and the Vendish of Styria, is *calamita.* This word appears to be of Greek origin, and is given by Pliny as the name of a *small green frog.* The application of the term to the magnet is explained by a fancied resemblance to that animal in the magnetic needle, when poised on water by means of small reeds, projecting beneath it like the legs of a frog in motion, according to the usual mode in early times, in Europe, of adapting it to the mariner's use. But that the idea of such a resemblance was not original in Europe, one might be led to suspect, from the analogy of the Birman name for the compasss *anghmyaoung*, which signifies *lizard*, and will be rendered still more probable by evidence, hereafter to be given, that this mode of using the magnetic needle in navigation, was adopted in China about

* M. Klaproth was a Prussian, born at Berlin in 1783, and died at Paris in 1835.

eighty years previous to the earliest mention of the needle itself in any European writer.

Many of the terms applied to the magnet, both in European and Asiatic languages, allude to one or another of its characteristic properties. Among these, the French *l'aimant, the lover,* and the Spanish and Portuguese *iman,* with the same signification, is particularly worthy of notice, as having its precise correspondent in the Chinese *thsu chy,* of which a celebrated Chinese naturalist who flourished in 1580, observes: "if this stone had a love for the iron, it would not make it come to it," and a writer of an age eight centuries earlier: "The magnet draws the iron like a tender mother, who causes her children to come to her, and it is for this reason, that it has received its name." In India also, the magnet was of old personified as capable of tender attachment, in the Sanscrit name *thoumbaka, the kisser,* from which are derived several appellations now in use in that country, as *tchoumbok* in the Bengalee, and *tchambak* in the Hindostanee. Another Sanscrit term for the magnet is *ayaskanta, the loved stone,* or *ayaskanta-mani, the stone loved by iron,* which also the Bengalee retains; and in the Cingalese the magnet bears the name of *kandako-golah, the stone that loves,* which is apparently composed of the Sanscrit *kanta, loving,* and the Cingalese *galah, stone.*

The language of Mussulman Asia derive the names which they give to the magnet, mostly, from the Greek (*Magnetes:*) thus in Arabic we find *al-maghnathis;* in Persian *sang-i-maghnathis—the stone maghnathis,* and in Turkish *milknathis.*

Of the names given to the magnetic needle and compass, one which is to be met in many European languages, is the Italian *boussola,* the Portuguese *bussola,* the Spanish *brujula,* the French *boussole,* etc. Some Italian authors have claimed this term as original in their own language, and have sought to argue, from its having been so widely adopted in other languages, in favor of their national assumption of the honor of having invented the compass. The word cannot, however, be deduced from an Italian origin any more reasonably than from an assumed English diminutive *boxel,* no such diminutive existing, which some writers have attempted; nor does the Greek *Mponsonlas* bear the appearance of being original with that language. The derivation of both the Greek *Mponsonlas* and the Ii an *boussola,* and so of the corresponding words in other languages of Europe, is to be found in the Arabic *mouassala—arrow,* an initial *m* of Arabic words, having been very commonly changed, in the middle age, to *b. Mouassala* is itself one of the names given to the magnetic needle in Arabic.

Among the Turks and Persians, the terms for the compass, in most general use, is *kibleh-nameh,* or *kibleh-numa—indicator of the kibleh,* which is the direction to be faced in prayer, and, consequently, as Mecca lies to the south of most of the Mohammedan countries, *the south.* With this is erfectly synonymous the Chinese appellation *tchi nan—indicator of the outh* and the Mandchow *dchoulesi dchorikou,* for the magnetic needle. The Persians undoubtedly derived their name for the compass, *kibleh-nameh,* from the Chinese, for it is a peculiarity limited to the Chinese and those who have adopted their civilization, that they make the south their principal pole, segarding this as the anterior, and the north as the posterior side of the world; according to which they also place the throne of their Emperor, and the principal facade of their edifices, so as to front the south.

As the Hindoos have never been addicted to navigation, the knowledge of the compass seems to have been introduced but very late among them and the names they give to it are for the most part foreign. In the English provinces of India it is called *compass*, from the English; and in the Cingalese of Ceylon, *kompasouwa*, a corruption of *compass*. The Hindostanee has abopted the Persian term [*kibleh-numa—indicator of the south.*

In these comparisons of the most current terms for the magnet and the magnetic needle and compass, in the eastern and western world, there is not a little to lead one to believe that the discovery of the wonderful properties of the magnet originated in the remote Orient, and was gradually communicated to the nations of the west. But there are historic notices of the magnetic needle and compass, which also point to the east as the field of the first discovery of the polarity of the magnet and its applicability to navigation.

The earliest explicit mention of the magnetic needle, by any European writer, is in a political work of Guyot de Provins, dating about the year 1190. The next as to date is found in the *Historia Orientalis* of Jacques de Vitry, referring to the year 1204: "Adamas in India reperitur—ferrum occulta quadam natura ad se trahit. Acus ferrea, postquam adamantem contigerit, ad stellam septentrionalem, quae velut axis fermamenti, aliis vergentibus, non movetur, semper convertitur, unde valde necessarius est navigantibus in mari." It would be difficult to give any authority to this passage, and not recognise the east as the source of knowledge, among Europeans, of the polarity of the magnet. Not long before the year 1260, Brunetto Latini, "maitre du divin Dante," being on a journey in England, saw the magnet and the magnetic needle for the first time, in visiting Roger Bacon, and a fragment of a letter of his, written on the occasion, which has been preserved, describes them thus: "He shew me the magnet, a disagreeably looking black stone, it readily unites with iron; a small needle is taken into the hand and fastened in a bit of reed, then it is put upon a surface of water, and one stands over it, and the point turns towards the star, (the polar star;) in case the night is obscure, and neither star nor moon is seen, the mariner may keep to his right course."

Albertus Magnus, of Swabia, who flourished about the middle of the thirteenth century, quotes in a work of his, "*De Mineralibus*," a passage from a "treatise concerning stones," attributed to Aristotle, of which the following portion merits particular attention: "Angulus magnetis cujusdam est, cujus virtus apprehendi ferrum est ad *zoron*, hoc est septentrionalem, et hoc utuntur nautæ. Angulus vero alius magnetis illi oppositus trahit ad *aphron*, id est meridionalem: et si approximes ferrum versus angulum zoron, convertit se ferrum ad zoron, et si ad oppositum angulum approximes, convertit se directe ad aphron." Vincent de Beauvais, a cotemporary of Albertus Magnus, has left a similar passage, likewise quoting Aristotle, in his "*Speculum Naturale*:" "Angulus quidem ejus cui virtus est attrahendi ferrum, est ad *zaron*, i. e. septentrionalem, angulus autum oppositus, ad *aphron*, i. e. meridiem. Itaque proprietatem habet magnes, quod si approximes ei ferrum ad angulum ipsius qui zaron, i. e. septentrionem respicit, ad septentrionem se convertit, si vero ad angulum oppositum ferrum admoveris, ad apron, i. e. meridem se movebit." The names given in these two passages to the north and south pole, *zoron* or *zaron*, and *aphron*, are the Arabic, north and south. As to the work here attributed to Aristotle, under the title of a "treatise concerning stones," we have no such Greek text of this author, and it is doubtful if ever he wrote such a book. There is an Arabic treatise entitled *the Book of Stones*, composed by a certain Lucas, son of Serapion, but purporting to be a translation from Aristotle, which Baron De Sacy has shown to be the true source of citations under the name of Aristotle, in the writings of Teifachi and Beilak Kibdjaki; and very probably Albert and Vincent have quoted this same work in the account of the polarity of the magnet. However, the names *zoron* and *aphron*, applied by these authors to the two magnetic poles, are sufficient to prove that they derived their knowledge of the magnet's polarity from an oriental source.

But there is no evidence that the Arabs were the inventors of the magnetic needle. It may, indeed, have been in use among the Arabian navigators, before it was noticed by men of science; but we have in no Arabic work any mention of it which goes back beyond the year 1242. In this year, Beilak Kibdjaki made a voyage from Tripoli to Alexandria, and in his treatise entitled *the Treasure of Merchants, touching the knowledge of stones*, he has recorded his observations on that occasion, respecting the magnetic needle. "As to the properties of the magnetic needle," he writes, "it is to be observed, that the captains who navigate the sea of Syria, when the night is so obscure that they can see no star by which to steer their course according to the four cardinal points, place a pitcher full of water in the interior of the vessel, to be sheltered from the wind, and then take a needle and pass it through a piece of wood or reed, forming a cross, which they throw into the water in the pitcher prepared for the purpose, and it floats. They then take a magnet large enough to fill the palm of the hand, or smaller, and bring it near the surface of the water, giving their hands a rotary movement towards the right, so that the needle turns about on the surface of the water. Then they withdraw their hands all of a sudden, and truly the needle points north and south. I myself saw this done on my voyage from Tripoli in Syria to Alexandria, in the year 640," (or 1242 of our era.) "They say," he continues, "that the captains who navigate the Indian ocean supply the needle and piece of wood by a sort of fish, of thin iron, hollow, and so made with them, that, when thrown into the water it floats, and shows by its head and tail the two points of north and south." So early, then, as the year 1242, the water compass was in general use on the Syrian waters, and was known, it is to be presumed, as well to Arabian as to European navigators. But what this author, Beilak, says of the peculiar form, according to report, of the magnetic needle which was used in the Indian ocean, indicates an independent knowledge of it in that quarter of the globe; and recalling the signification of *calamita, little green frog*, and the Burman appellation for the compass, meaning *lizard*, leads one to look further to the east than any of the Mohammedan countries for the original discovery of the polaric properties of the magnet. We shall presently see that between 1111 and 1117, the Chinese made a water compass exactly such as Beilak describes that which he saw in 1242, in the Syrian waters, and also like that which Jacques de Vitry saw within the first half of the thirteenth century, in the possession of Roger Bacon.

The Chinese have been acquainted with the magnet and its attractive force and polarity from the highest antiquity. In a Chinese dictionary, composed in 121, by Hiu-tchin, the magnet is mentioned, as a "stone with which one can give direction to the needle." About a hundred years later, as we learn from P. Gaubil, in his history of the dynasty of the Thang, there is found a distinct notice of the compass as an instrument by which to ascertain the points of north and south. Under the dynasty of the Tsin, (i. e. between 265 and 419,) Chinese vessels were already steered to the south by means of the magnet. But the Chinese were acquainted with the declination of the needle, also, a long while before it was supposed to be first discovered by Columbus. In a medical natural history, composed between the years 1111 and 1117, the author gives the following notice of the magnet and of its properties. This is the most ancient *description* of the magnet found as yet in any Chinese book: "The magnet is covered over with little bristles slightly red, and its superficies is rough. It attracts iron, and unites itself with it; and for this reason it is commonly called "the stone which licks up iron." When an iron point is rubbed upon the magnet, it acquires the property of pointing to the south; yet it always declines eastward, and is not perfectly true to the south. On this account, a thread of new cotton is taken and attached by a particle of wax as large as a mustard-seed, exactly to the middle of the iron, which is thus suspended in some place where there is no wind. The needle then points, without variation, to the south. If the needle is passed through a little tube of thin reed, which is afterwards placed on water, it directs to the south, but always with a declination to the point *ping*, that is to say, east $\frac{5}{6}$ south." The accuracy of this observation, referring it to the capital city of the empire, is confirmed by P. Amiot, who, after taking magnetic observations at Peking for several years, found the variation of the needle there to be constantly from 2° to 2° 30′.

Upon a due consideration of all these historic data, in connection with the comparison of the European and Oriental names of the magnet, the magnetic needle, and the compass, it cannot appear to any one to be a rash conclusion, that the knowledge of the natural production, as well as of its wonderful applicability in navigation, existed first in China, and was communicated by the intervention of the Arabs to the nations of Europe, probably on occasion of the more frequent intercourse between Europe and the east, to which the crusades gave rise.

But before the Chinese had applied the magnet to use in navigation, it was employed among them in the construction of *magnetic cars* by which travellers on land directed their course. Not to cite those stories of the Chinese relative to these cars which lose themselves in a fabulous antiquity, the earliest historic allusion to them dates in the first half of the second century, when the Emperor Tcheou Koung, as it is related, gave to some ambassadors from Tonkin and Cochin-China "five travelling cars, so constructed as always to indicate the direction of the south. The cars which showed the south," it is added, "always went in front, to show the way to those who were behind, and to make known the four cardinal points." In the year 235, a Chinese Emperor ordered one Makiun to construct a "car which would show the south," to be deposited in a sort of Museum; and we are informed that the invention had then, for some time, been lost, and was recovered by the ingenuity of Makiun. In a book of annals of the dynasty of the Tsin, the magnetic car of a previous age is thus described: "The figure sculptured in wood, standing upon the magnetic car, represented a genius dressed in feathers. In whatever direction the car inclined or turned, the hand of the genius pointed invariably to the south. When the emperor went out in form, in his carriage, this car led the van, and served to show the four cardinal points." From the year 236, the construction of a magnetic car seems to have been a puzzle which different Chinese Emperors proposed to the ingenious men of their courts, and the knowledge of the invention appears to have been confined within very narrow limits.

Between 806 and 820, under the Thang dynasty, were first constructed cars called *Kin koung yuan*. These were magnetic cars to which had been added a sort of drum called *Ki li kou*, a piece of mechanism which may remind one of some curious public time-pieces still to be seen in old cities of Europe. A *drum car* is thus described by a Chinese author: "It had two stories, in each of which was a wooden man holding erect a mallet of wood. As soon as the car had run one *ly*,* the wooden man of the lower story struck a blow upon a drum, and a wheel placed at the middle of his height made one revolution. After the car had run ten *lys*, the wooden man of the upper story struck a little bell."

The magnetic car cannot be traced later than 1609. In that year was published a celebrated Encyclopedia, which contains the following passage, accompanying a design of the human figure which was placed upon the magnetic car: "This is a car ornament, of which the dimensions are as follows: It is one foot and four inches in height, and in breadth at the bottom seven inches and four lines. At the extremity of the axle-tree of the car is pierced a round hole of three inches and seven lines in diameter. In this hole moves a peg of the same size, on which is placed the figure of a man sculptured in *jade*,† whose hand always points to the south. This figure had motion in the hole, and turned. In the years Yan Yeou, (from 1314 to 1320,) it was an object to determine the position of the monastery of Yuo mou ngan, and the figure on the magnetic car was made use of for this purpose.—*Silliman's Journal.*

ON THE FIRST, OR SOUTHERN COAL FIELD OF PENNSYLVANIA; by M. Carey Lea.

Among the numerous sources of wealth possessed by Pennsylvania, are her inexhaustible iron mines and coal beds. It must be acknowledged by all, that they constitute her true wealth, and they will contribute greatly to elevate her in the scale of national prosperity.

Her coal beds are peculiarly valuable, possessing as she does, every variety of this fuel, from the hardest *anthracite*, to the most highly charged *bituminous coal.* She can supply those kinds most suitable for economical purposes, for generating gas, for making and working iron, in a word, for all the many uses to which this substance is applied. It is chiefly to her mines that the steam navigation of the Atlantic coast must look for its supplies, and the quantity thus consumed, though at present it may appear inconsiderable, will probably be soon enormously increased.

It has been the opinion of my father for many years, that the hard or highly carbonized anthracite of the eastern end of the southern coal field, changes to the bituminous in the western end, by nearly regular gradations, the veins probably being continuous from the one point to the other. A case analogous to this is presented to the anthracite and bituminous coal of South Wales.

With a view of testing this opinion, and for other purposes, a laborious set of analyses was undertaken, from specimens known to be authentic, in the laboratory of Prof. Booth. The method of analysis pursued was the following. One gramme of the coal, reduced to a fine powder in an agate mortar, was carefully and gradually heated, in a platina crucible having but one small aperture, in order to drive off the volatile matter. When this was effected, the residuum was weighed, and the volatile matter thus ascertained. The crucible was then exposed to the highest heat of an alcohol blowpipe for some hours, until the carbon was thoroughly burnt out, and the ash was then weighed. The ash and volatile matter substracted from 1.000 gave, of course, the carbon.

* A measure of distance variously estimated. John Francis Davis, in his *History of China*, computes thirty *lys* in one English mile.
† A hard stone, of variegated hue.

It must be borne in mind that the analyses of the various coals from the Dauphin and Susquehanna coal company's lands, were made from specimens taken from explorations of veins, near the surface, and should therefore be considered in a great measure as crop coals.

*Analyses.**

No. 1. *Lehigh.*—The farthest eastern point at which coal is worked, is that owned by the Lehigh or Mauch Chunk coal company. The specimen of this coal examined was very pure, and of very conchoidal fracture; it was broken with difficulty and flew very much under the strokes of the pestle. Its color was a deep, brilliant black, with very narrow parallel lines of a still deeper color. It was a long time in burning and left a light fleecy ash of a very white color.

No. 2. *Tamaqua.* Little Schuylkill coal Co.'s mines.—This is the next important mining station, west of the Lehigh. The specimen was very brilliant with a somewhat conchoidal fracture, and so hard that white paper rubbed on a fresh fracture was scarcely marked by it. Its ash was greyish, white, and flocculent.

No. 3. *Pottsville.* Black Mine vein.--Next in order is the Pottsville coal. The specimen examined was of a fine brilliant appearance and very refractory. It came from the Black Mine vein, two hundred feet below water level, and contained layers of a darker and softer substance without any splendor, and by these it usually fractured. Ash deep red.

No. 4. *Pinegrove.* A specimen of this coal, from the "North Seam," three-fourths of a mile north of Sharp Mountain, was submitted to examination. It was brilliant, exhibited a conchoidal fracture, and was refractory under the hammer. Ash reddish yellow.

No. 5. *Black Spring Gap,* 26 miles from the Susquehanna. Fish-back back vein.—This is the next western point at which coal is worked, and from it, specimens of two veins were examined, this and the following. This one is devoid of lustre, and after burning, leaves a yellowish red ash.

No. 6. *Black Spring Gap.* Peacock vein.—The coal from this vein was brilliant, with a conchoidal fracture, and leaves a yellowish red, very light ash.

No. 7. *Gold Mine Gap,* 25 miles from the Susquehanna. Peacock vein.—This coal is brilliant, possessing a conchoidal fracture. Its ash was yellowish red, very bulky and light.

No. 8. *Rausch Gap,* 21 miles from the Susquehanna. Pitch vein, west side.—The specimen from this vein mas rather friable. Its fracture was somewhat conchoidal, and generally brilliant. Ash yellowish red.

No. 9. *Rausch Gap.*—Pitch vein, east side.—This coal is hard and rather brilliant, leaving a deep red ash, which changes to yellowish brown by a day's exposure to the air.

It will be seen that the portions of volatile matter in the two last are very early equal. The difference in the hardness and in the ash, probably esults from the one specimen having been taken from nearer the crop than the other.

No. 10. *Yellow Springs Gap,* 16 miles from the Susquehanna. Backbone vein.—This specimen possessed but little lustre and left a dark red ash.

* The analyses have been condensed into a tabular form for greater economy of room and perspecuity; the numbers will be found to correspond with the table.—*Eds.*

No. 11. *Yellow Springs Gap.* Vein next north of Central Ridge.—This is a dense, black coal, which cokes. Its ash is pale and salmon color.

No. 12. *Rattling Run Gap,* 13 miles from the Susquehanna. Perseverance vein.—The specimen analyzed was brilliant, with a clear, bright fracture, and burned with a bright flame. Its ash was dark red.

This terminates our series, being the last important coal station where a vein fit for working has been discovered, so far as exploration has gone on.

It would appear from these results, that the bituminous qualities of the coal increase with considerable regularity from Tamaqua to Rattling Run, that from Mauch Chunk being an exception, although its excess of volatile matter may probably be attributed to its containing a large proportion of water.

Specimens of two other American coals, were examined for comparison with the preceding. These were from the Blossburg or Tioga mines, and from Cumberland, Md.

No. 13. *Tioga.*—The Tioga oal field is a detached portion of the eastern extremity of the great Allegany coal basin. The specimen examined was of a medium hardness, and its fractures were sometimes brilliant, sometimes altogether devoid of lustre. Its ash was cream-colored, inclining to grey.

No. 14. *Cumberland, Md.*—This coal is brilliant, with an even fracture, and cream-colored ash, passing to grey.

No. 15. *Black Spring Gap.* Grey vein.—This remarkable vein, as mentioned by R. C. Taylor, Esq., in his "Report of the Stoney Creek Coal Estate," is about seventeen feet thick, containing much fine coal, with a vein near the centre, two or three feet thick, of coal of a greyish color, which has given the name to the whole. The specimen of this included vein, in my possession, closely resembles plumbago in appearance. It burns with little flame, leaving a yellowish red ash.

Table of analyses of coals from Pennsylvania. The numbers refer to those prefixed to the paragraphs.

No.	Locality.	Carbon.	Volatile matter.	Ash.
1.	Lehigh,	.870	.073	.057
	Another analysis of the same gave,	.869	.075	.055
2.	Tamaqua,	.910	.055	.035
3.	Pottsville,	.884	.068	.048
4.	Pinegrove,	.859	.072	.069
5.	Black Spring Gap. Fish-back vein,	.840	.065	.095
6.	Black Spring Gap. Peacock vein,	.886	.071	.043
7.	Gold Mine Gap. Peacock vein,	.830	.090	.080
8.	Rausch Gap. Pitch vein, west side,	.771	.109	.120
9.	Rausch Gap. Pitch vein, east side,	.789	.110	.101
10.	Yellow Springs Gap. Back-bone vein,	.775	.110	.115
11.	Yellow Springs Gap. Vein next N. of Central Ridge,	.747	.148	.105
12.	Rattling Run Gap,	.761	.169	.070
13.	Tioga,	.725	.175	.100
14.	Cumberland, Md.,	.754	.170	.076
15.	Black Spring Gap. Grey vein,	.860	.045	.095

A comparison between the coals of Cumberland, Md., Blossburg, Penn., Dauphin Co., Penn., and South Wales, shows a remarkable similarity of composition as respects volatile matter. The greatest difference, in fact, scarcely exceeds one half of one per cent., as will be seen by the following table.

	Carbon.	Volatile matter.	Ash.
Cumberland,	.754	.170	.076
Blossburg, or Tioga,	.725	.175	.100
Dauphin,	.761	.169	.070
South Wales, Dowlais, (by Berthier,)	.795	.175	.030

We give place to the communication kindly sent us by Mr. Redfield, in hopes that engineers will give to the subject the attention it demands. No class of men is better able to collect information of a character calculated to advance the science of meteorology.

THE NEW BRUNSWICK TORNADO.—REMARKS RELATING TO THE TORNADO WHICH VISITED NEW BRUNSWICK, IN THE STATE OF NEW JERSEY, JUNE 19, 1835, WITH A PLAN AND SCHEDULE OF THE PROSTRATIONS OBSERVED ON A SECTION OF ITS TRACK. BY W. C. REDFIELD, ESQ.*

[From the Lond. Phil. Mag. and Jour. of Science. Revised by the Author.]

In a paper printed in the American Journal of Science, in which I referred to the support given by Prof. Bache to Mr. Espy's theory of storms, at the meeting of the British Association in 1838, founded upon observations made on the New Brunswick tornado, I have stated, that in my own examinations I had observed numerous facts which appear to demonstrate the *whirling* character of this tornado, as well as the *inward* tendency of the whirling vortex at the surface of the ground; and further, that the direction of rotation was *towards the left*, as in the North Atlantic hurricanes.† It was due to Professor Bache that my observations should be brought forward; a task which has been too long delayed, partly from a desire that he would revise his former conclusions. The facts now presented form part of the evidence to which I then alluded.

If the effects which I present for consideration be due to "a moving column of rarefied air without any whirling motion at or near the surface of the ground," as maintained by Professor Bache,‡ we might expect to find a relative uniformity in these effects on the two opposite sides or margins of the track. How far this is the case may be seen by inspecting the observations which are found upon the annexed plan of prostrations.

The occurrence of these tornadoes appears to have been noticed from the earliest antiquity; and their violence has been considered as the effect of an active whirling motion in the body of the tornado; this peculiarity of action having often been supported by the testimony of eye-witnesses.

The whirling motion, however, has not been recognized by Prof. Bache, Mr. Espy,§ or Prof. Walter R. Johnson,‖ in their several accounts of the New Brunswick tornado; these writers having been led to adopt or favor

* [Communicated by Sir John F. W. Herschel, Bart.] This paper was intended by its author to have been read at the late meeting of the British Association in Glasgow, but was unfortunately detained.—J. F. W. H.

† Amer. Jour. of Science, Oct. 1838, vol. xxxv, pp. 206, 207.

‡ Transactions of Amer. Phil. Society, vol. v, p. 417, New Series.

§ Trans. Amer. Phil. Society, vol. v, New Series.

‖ Journ. Academy, Nat. Sciences of Philadelphia. vol. vii, part ii.

a theory of ascending columns in the atmosphere, founded on the supposed influence of calorific expansion accompanying the condensation of vapor.

It is remarkable that previous to this period the evidences of the rotation or other characteristic action of tornadoes appear not to have been duly examined and recorded, nor even to have received the distinct consideration of scientific observers. We are, therefore, left to seek out the peculiarities of their action, by examining the direction of the prostrations and other effects of the wind; and from a careful induction from the effects which are thus registered as by the finger of the tornado, we may hope to arrive at satisfactory conclusions.

If the numerous prostrations of trees and other objects, which may be observed in the path of a tornado, be the effects of a violent whirlwind, it appears most reasonable to infer that this whirl had the common properties which may be observed in all narrow and violent vortices, viz. *a spirally descending and involuted motion* of the exterior and lower portions of the vortex, rapidly quickened in its gyrations as it approaches toward the centre or axis of the whirl, and thence continued (in the case of the whirlwind) spirally upward, but gradually expanding in its spiral course by an evolute motion in ascending towards the extreme height of the revolving mass.

If we now contemplate the action of this whirling body, while in a state of rapid progression, on the several objects found in distinct portions of its path, we may expect to witness effects of much complexity, particularly as regards direction; and, also, that amid this apparent complexity, some clue may be obtained that will serve to indicate or establish the true character of its action. Some of the effects which may be expected, or observed, will be here considered.

1. We may expect to find, in the path of the whirlwind, strong evidence of the inward or vorticular course of the wind at the earth's surface; the violence of which inward motion is clearly indicated by the force with which various objects, often of much weight, are carried spirally upward about the axis of the revolving body.

Now the effects of this inward vorticular motion at the surface of the ground, are clearly manifested in the cases before us; and are also well illustrated by Prof. Bache, in his paper on this tornado, although referred by him to a different action.*

2. As the effects which may be observed at various points in the track were produced at different moments of time, and by forces acting in different directions, as well as of various intensities, we may expect to find great diversities in the several directions of the fallen trees and other prostrated bodies; and further, as all the forces, in addition to their inward tendency, have likewise a common tendency in the direction pursued by the tornado, we may expect to find, also, full evidence of this progressive force in the direction of the fallen bodies.

These effects, I need hardly state, are distinctly observed in the case before us; and appear likewise from the observations of Professor Bache. The results already noticed have been observed also in the tracks of other tornadoes: so that a general inclination, both inward and onward, amid the various and confused directions of the fallen bodies, is distinctly recognized by all parties to this inquiry.

* Transactions of American Philosophical Society, vol. v.

3. It has been often noticed, that where two fallen trees are found lying across each other, the uppermost or last fallen points most nearly to the course pursued by the tornado.

In view of the facts above stated, much pains have been taken to establish, by induction, a central and non-whirling course in the wind of the tornado; first inward and then upward, like that resulting from a common fire in the open air. I do not propose to notice the insuperable difficulties which appear to attend this hypothesis. It is important to state, however, that all the above mentioned effects, when theoretically considered, are, at least, equally consistent with the involute whirling action of an advancing vortex. This important consideration I have not seen recognized by the advocates of the non-whirling theory; and it seems proper, therefore, to point out, as we proceed, other and more distinguishing effects of the whirling action.

4. It has been noticed, also, that the directions given to broken limbs and other bodies, by the successive changes in the direction of the wind as the tornado passed over, have been found in opposite courses of change, on the two opposite sides of the track.

This fact, too, has been strongly urged as disproving a rotary motion. But, unfortunately for the objection, this effect accords fully with the rotary action of a progressive mass of atmosphere; as is well known to all who clearly understand the theory of rotary storms.

In all such whirling masses the successive changes in the direction of the wind *result solely from their progressive motion*, and necessarily take place in opposite directions or courses of change on the two opposite sides of the advancing axis. This indication fails, therefore, as a theoretic test; and I now proceed to notice others, which are peculiar to a progressive whirling action.

5. In considering further the effects of such action, we may expect to find that the greatly increased activity of gyration which is always observed near the centre of a vortex, will be indicated by a more violent and irregular action in and near the path pursued by the axis of the whirlwind, than is found under its more outward portions.

This effect is often strikingly exhibited in the path of tornadoes; while, in the supposed ascent of a non-whirling column, it would seem that no part of the surface would be so much exempted from its action, and particularly from its power of prostration, as that lying near its centre.

6. As the effect of rotation must be to produce, on one side of the advancing axis, a reverse motion which is contrary to the course of the tornado, it is evident that on this side the prostrating power will be much lessened; that the cases of prostration, therefore, will be here less numerous; and that some of these, at least, will be produced in a backward direction, more or less opposite to the course of the tornado. By this criterion, not only the whirling movement, but the direction of the rotation also, may be clearly ascertained.

This effect is best observed by comparing the two opposite margins of the track, and is strongly exemplified in the case before us. Here we find, that most of the trees prostrated within five chains (110 yards) from the northern or left-hand margin of the track, lie in directions which are more or less backward from the course of the tornado. The prostrations in this part of the track are also for the most part less general than on the opposite side of the axis,* a greater portion of the trees being left standing.

* There was a vacant space in the belt of wood, immediately to the right of the line *c c* or axis of the tornado, owing to which the effect mentioned does not appear so obvious in the figure.

It sometimes happens, owing perhaps to the inward or involute motion having exceeded the progressive motion at a particular point, that some inclination backward will be found in the prostrations on the progressive side of the whirl, as seen on the sketch, Nos. 77 to 80. But these unfrequent cases by no means compare with the numerous backward and sometimes *outward* prostrations, found on the reverse side of the whirl, as illustrated by Nos. 1, 3, 4, 7, 9, 10, 12, 13, etc., on the left side of the track. Thus we find here a satisfactory indication that this tornado was a whirlwind; and that the course of its rotation was to the *left* in front.

7. It is also apparent, that the prostrating power of a whirlwind on the side of its reverse motion as just considered, will be limited to a shorter distance than on the opposite or progressive side of its axis.

This is seen in the more limited *extent* of the prostrations on the north or left margin of the track, as compared with the extent of those which incline inward on the right side of the apparent axis. There were many trees standing beyond the northern border of the track, but none had fallen.

8. It follows, in like manner, that on that side of a whirlwind in which the rotary motion coincides with the progressive movement, the prostrating power will not only be increased in its intensity, but will also be effective over a wider space; and that few, if any, of the prostrated bodies will be found to have been thrown backward.

In the case before us, as may be seen in the sketch, the prostrations are found to extend on the southern or right side of the apparent axis to a distance nearly twice as great as on the left side. The same general result has also been noticed in the tracks of other tornadoes which I have examined.

The facts here considered are too important to be overlooked, and seem fully to establish both the whirling action and the course of rotation.

9. If a rotative action be exhibited, the mean directions of all the prostrations, on each of the two opposite sides, will differ greatly in their respective inclinations to the line of progress, and the mean direction of those on the reverse side will be found more backward than on the opposite side, where the rotative course coincides with the progressive action.

In the case before us, the mean direction of all the prostrations on the right side of the track is found to incline 52 degrees inward from the line of progress. The course of the tornado is here taken to be east; although for the last half mile its course had been a little north of east. On the left side, the mean direction is found to be S. 3° W., or 93 degrees inward and backward; a difference in the mean inclination from the course on the two sides of 41 degrees.*

If we now take the indications afforded by the two exterior portions of the track, to the width of five chains on each side, where the effects are more distinctive in their character, we find on the right side a mean inward inclination of 46 degrees, the mean direction being N. 44° E.; while on the left side of the track the mean inclination is not only inward but 48 degrees backward, the mean direction on this side being S. 48° W. We have thus a mean difference in the inclination of the fallen trees, on the two exterior portions of the track, of no less than 92 degrees.

* The inclination of the fallen trees from the course, on both sides the axis, are reckoned inward and backward.

These indications seem conclusive, also, in favor of the whirling action in the direction from right to left.

10. Although of less importance, it should be mentioned that the diminished action of the tornado which is commonly observed on the hillsides and summits over which it passes, and the greatly increased action in the bottoms of the valleys, and even in deep ravines, afford a strong argument against ascribing the effects to the ascent of a non-whirling rarefied column; as the latter, it wonld seem, must act with greater force on the hillsides and summits than in the bottoms of valleys. The general correctness of the observation above stated cannot justly be questioned.

11. The sudden and extraordinary diminution of the atmospheric pressure which is said to take place at the points successively passed over by a tornado, causing the doors and windows of buildings to burst outwards, seems to afford strong confirmation of a violent whirling motion; for an effect of this kind is necessarily due to the centrifugal and upward force of the vorticular action in the interior portion of the whirlwind. There are no other means known by which such an abstraction of pressure can be effected in the open air. An increase of calorific elasticity, if such were produced, either generally or locally, would not greatly disturb the equillibrium of pressure, being resisted by the surrounding and incumbent weight of the entire atmosphere. Besides, the immediate effect of such increased elasticity might rather be to burst *inward* the windows and doors of buildings exposed to its action.

Some of the more important indications mentioned above appear also from an examination of Prof. Bache's observations; although the latter be not definitely located by him, as regards the extreme borders of the track. Thus, in Fig. 7, of Professor Bache's paper, assuming the course as the tornado to be east, and rejecting a few observations near the centre, to avoid error, we find in twenty observations on the right side of the track, a mean inward inclination of 64 degrees, and for nine observations on the left side, a mean inclination, reckoned inward and backward from the course, of 104 degrees, being 14 degrees backward.

It is stated by Prof. Bache, "that the trees lying perpendicular to the track of the storm, are not those furthest from the centre of that track." This generalization accords with my own observations; but can hardly be reconciled with an inward non-whirling motion in the tornado.

It may appear to some, that in the case of a whirlwind the greater portion of the prostrations on the reverse side of the axis should be found in backward direction; and so they would undoubtedly be found, were it not for the inward and the progressive action. But the force is here so far lessened by the reverse action above noticed, that in most cases only a small portion of the trees exposed will be thus prostrated; while the greatest force of the whirlwind, on this side, is felt near its last or closing portion and towards the apparent axis, where the inward, together with the rotative and progressive forces, seem to combine their influence in the closing rush towards the heart of the receding vortex. This appears to account for the nearly opposite directions of prostration found on this side, and it is apparently by this more violent closing action, that many trees which were first overthrown in a direction nearly across the centre of the path, were again moved from their position, or swept onward nearly in the course of the tornado. It is proper to remark here, that an attentive examination of these effects has served to convince me that on the right and more central portions of the track the prostrations for the most part take place either at the outset or under the middle portions of the whirlwind; while on the left or reverse side, up to the line of the apparent axis, and even across the latter, they occur chiefly under the closing action of the whirl, as above described. The violent effects of this central and closing action are more clearly seen as we advance from the left-hand margin towards the centre or apparent axis of the path.

From the causes to which I have just alluded, the effects are usually more violent on and near the line passed over by the axis, than in other portions of the track. This line of greatest violence is found to coincide nearly with the line which separates the inwardly inclined prostrations of the twe opposite sides of the track.* The latter line or apparent axis of the track is sometimes called the line of convergence, and is indicated on the figure by the line and arrow *c c*. Along this line, from the causes just mentioned, aided also by the elevating forces about the axis, many of the trees are swept onward, and left with their tops in a direction nearly parallel to the course of the tornado; forming an apparent, but not a just exception, to the more lateral direction which pertains to most of the trees prostrated by the onset of the whirlwind, near the central portions of the track. Indeed, the central or closing violence of the advancing whirl is here so great, that the trees are not unfrequently torn out of the ground and carried onward to considerable distances.

It is proper to state here, that in the tracks of all the tornadoes which I have had opportunity to examine, and in some, at least, of those examined by others, the course of rotation has been found the same as in the case before us.†

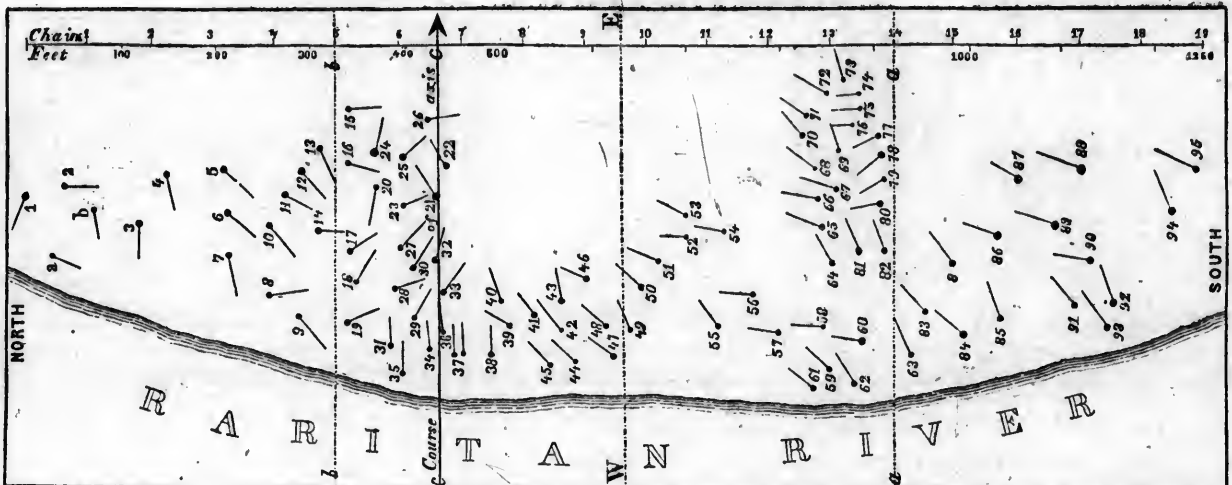
In order to make a just and satisfactory examination of the effects of a tornado, it appears necessary to select portions of the track where the extension of wood or single trees, on each side, is found sufficient to mark clearly the exterior limits of the prostrating power, and where the effects on both sides of the axis are also clearly developed. Our next care should be to ascertain, as near as may be practicable, the line which separates the opposite convergence of the two sides, noticed above as the axis or line of convergence. We should then determine the general direction of this line and of the track at the place examined; which being done, we may proceed to measure the distance to which the prostrations are extended on each side, and then carefully to take the position and direction of prostration of each and of all of the fallen bodies, nothing with care, also, any other phenomena which may serve to aid our inquiries. We may thus obtain valuable materials for future analysis; and this course of investigation, if faithfully pursued, will, it is believed, remove all reasonable doubt of the rotative action of these tornadoes. An examination of their probable origin, and the causes of their enduring activity and violence, belongs not to the present occasion.

New York, 5th February, 1841.

* The line of greatest violence, for the most part, is found somewhat to the right of the line of convergence.

† As in the tornado which passed through Allegany county, New York, July 25th, 1838; described by Mr. Gaylord in the American Journal of Science, vol. xxxvii, p. 92.

NEW-BRUNSWICK TORNADO. (Plate I.)



Sketch of the Prostrations found on a section of the Track of the Tornado of June 19, 1835, on the bank of the Raritan, opposite the City of New Brunswick, in the State of New-Jersey.

Explanations.—The east bank of the river is here covered with a belt of wood; the latter having a very irregular outline on the east, where it is bounded by a clear field. The line *c c* represents the apparent course of the axis of the tornado: W. west, E east. The large dots on the several figures show the root ends of the trees, which were chiefly a species of cedar. In all these cases of prostration, part of the roots were still fast in the ground. Course of the tornado east. The approximate positions of the several trees are in many cases slightly changed in the sketch, for the purpose of a distinct exhibition of each.

Note.—This bank of the river is intersected by small ravines with wooded margins, one of which is nearly opposite to chain 5, and another is near chain 13, and which cause most of the irregularity in the wooded outline.

SCHEDULE OF THE PROSTRATIONS

Observed on a Section of the Track of the New-Brunswick Tornado, of June 19th, 1835.

TABLE I.

Left side of the track to the line *b b*—5 chains.

No.	Direction of Prostration.	Inclination. Inward and backward.
a	Tree lies S. 20° W. . .	110°
b	.. .. S. 80 W. . .	170
1	.. .. N. 67 W. . .	203
2	.. .. S.	90
3	.. .. W.	180
4	.. .. S. 80 W. . .	170
5	.. .. S. 40 W. . .	130
6	.. .. S. 40 W. . .	130
7	.. .. S. 80 W. . .	170
8	.. .. S. 10 E. . .	80
9	.. .. S. 50 W. . .	140
10	.. .. S. 50 W. . .	140
11	.. .. S. 26 W. . .	116
12	.. .. S. 50 W. . .	140
13	.. .. S. 65 W. . .	155
14	.. .. South . . .	90

Mean direction, 16 cases, S.48°W. Mean inclination from course, inward and backward, 138 degrees.

TABLE II.

Left side of the axis, from the line *b b* to *c c*—1½ chains.

No.	Direction of Prostration.	Inclination.
15	Tree lies S. 2° E. . .	88
16	... .. S. 12 W. . .	102
17	.. .. S 35 E. . .	55
18	.. .. S. 62 E. . .	28
19	.. .. S. 25 E. . .	65
20	.. .. N. 80 W. . .	190
23	.. .. S. 20 E. . .	70
24	.. .. S. 80 E. . .	10
25	.. .. S. 45 E. . .	45
26	.. .. S. 10 E. . .	80
27	.. .. S. 45 E. . .	45
28	.. .. S. 20 E. . .	70
29	.. .. S. 60 E. . .	30
30	.. .. S 60 E. . .	30
31	.. .. East . . .	00
32	.. .. S. 75 E. . .	15
33	.. .. S. 56 E. [Included as belonging by its inclination to this table.]	34
35	.. .. East . . .	00

Mean direction, 18 cases, S. 37° E. Mean inclination inward, 53 deg.

TABLE III.

Right side of apparent axis from line *c c* to W E—3 chains.

No.	Direction of Prostration.	Inclination.
21	Tree lies N. 56° E. . .	34
22	.. .. N. 60 E. . .	30
34	.. .. N. 80 E. [Included as belonging by its inclination to this table.]	10
36	.. .. N. 85 E. . .	5
37	.. .. East (two) . .	0
..	.. .. East . . .	0
38	.. .. East . . .	0
39	.. .. N. 30 E. . .	60
40	.. .. N. 70 E. . .	20
41	.. .. N. 55 E. . .	35
42	.. .. N. 50 E. . .	40
43	.. .. N. 78 E. . .	12
44	.. .. N. 45 E. . .	45
45	.. .. N. 45 E. . .	45
46	.. .. N. 25 E. . .	65
47	.. .. N. 35 E. . .	55
48	.. .. N. 40 E. . .	50

Mean direction, 17 cases, N.60° E. Mean inclination inward, 30 deg.

TABLE IV.

Right side of axis, from line W E to line *a a*—4½ chains.

No.	Direction of Prostration.	Inclination. Inward and backward.
49	Tree lies N. 67° E. . .	23°
50	.. .. N. 45 E. . .	45
51	.. .. N. 22 E. . .	68
52	.. .. N. 3 E. . .	87
53	.. .. N. 30 E. . .	60
54	.. .. N. 10 E. . .	80
55	.. .. N. 35 E. . .	55
56	.. .. North . . .	90
57	.. .. N. 10 E. . .	80
58	.. .. N. 3 E. . .	87
59	.. .. N. 45 E. . .	45
60	.. .. N. 10 E. . .	80
61	.. .. N. 35 E. . .	55
62	.. .. N. 60 E. . .	30
64	.. .. N. 40 E. . .	50
65	.. .. N. 20 E. . .	70
66	.. .. N. 10 E. . .	80
67	.. .. N. 20 E. . .	70
68	.. .. N. 40 E. . .	50
69	.. .. N. 70 E. . .	20
70	.. .. N. 50 E. . .	40
71	.. .. N. 35 E. . .	55
72	.. .. N. 30 E. . .	60
73	.. .. N. 50 E. . .	40
74	.. .. North (two) .	90
75	.. .. North " .	90
76	.. .. North " .	90
77	.. .. N. 20 W. (clump of 3)	110
78	.. .. N. 35 W. . .	125
79	.. .. N. 30 W. . .	120
80	.. .. N. 10 W. . .	100
81	.. .. N. 65 E. . .	25
82	.. .. N. 70 E. . .	20

Mean direction, 33 cases, N. 24° E. Mean inclination, 66 degrees.

TABLE V.

Right side of track, from line *a a* to outward limit of prostration—5 ch.

No.	Direction of Prostration.	Inclination.
63	Tree lies N. 65° E. . .	25
83	.. .. N. 45 E. . .	45
84	.. .. N. 40 E. . .	50
e	.. .. N. 55 E. . .	35
85	.. .. N. 70 E. . .	20
86	.. .. N. 23 E. . .	67
87	.. .. N. 31 E. . .	59
88	.. .. N. 20 E. . .	70
89	.. .. N. 22 E. . .	68
90	.. .. N. 10 E. . .	80
91	.. .. N. 55 E. . .	35
92	.. .. N. 70 E. . .	20
93	.. .. N. 55 E. . .	35
94	.. .. N. 68 E. . .	22
95	.. .. N. 25 E. . .	65

Mean direction, 15 cases, N. 44° E. Mean inclination inward from course of tornado, 46°.

Mean direction of all the prostrations on *left* of axis, 31 cases, S. 3° W.—being 3° backward, or 93° inward and backward.

Mean direction on *right* of axis, 65 cases, N. 38° E.—being 52° inward from course.

Difference, of mean inclination on the two sides, 41 degrees.

Difference of opposite marginal sections (Tables I and V) 92 degrees.

AMERICAN
RAILROAD JOURNAL,
AND
MECHANICS' MAGAZINE.

No. 12, Vol. VI. New Series. | JUNE 15, 1841. | Whole No. 384. Vol. XII.

THE POST MASTER GENERAL VERSUS RAILROADS.

The Post Master General having passed some strictures upon railroads in his recent report, we shall, for the information of our readers, present them with his remarks and certain comments thereon.

"Notwithstanding the heavy increased expenditure consequent upon the act of 7th July, 1838, and although, instead of the supposed gradual increase of revenue, the receipts for the quarter ending 31st March last, present, as compared with the corresponding quarter of the year before, a diminution of more than *six* per cent., still the department would probably find sufficient relief in its future operations from the decrease of prices which, it may be calculated, will be hereafter demanded upon most of the routes, were it not for the continually increasing exactions in other branches of the service.

"To present this subject in its most intelligible form, the First Assistant Postmaster General has prepared a tabular view of recent proposals, that comparison may be made between the amount of present bids and the sums now paid for mail service upon the same routes. This table is hereto annexed, marked D.

"On an examination of this statement, it will be seen that, in some cases, the amount demanded by railroad companies for transportation of the mails is more *than two hundred per cent.* higher than is paid for coach service, upon roads forming connecting links between different railroad companies, upon the same main route, and that too, where the night service upon the railroads is less than that performed in coaches. Such demands deserve more consideration from the fact that, whilst at the recent lettings in New York and in the six Eastern States, the accepted service by coaches and other modes of conveyance has been secured at an average saving of *twenty-two* per cent. upon the contracts of 1837, there are but few instances where the demands of incorporated companies have not been increased in such manner as imposed upon me the necessity of suspending the contracts. Nor is the extravagant price demanded for mail transportation upon railroads the only manner in which these incorporations affect the revenue of this department. The facilities secured by this mode of conveyance for sending letters by private hands, very seriously diminish the receipts of the offices upon these routes. A single illustration will establish this assertion.

"Boston is one of the most important points of railroad concentration in the Union. Its business prosperity is proverbial; and yet in that city, the quarter ending 31st March last, shows, as compared with the corresponding quarter of the year before, a decrease in postage receipts of *three thousand one hundred ninety-five dollars*—being double the amount of diminution to be found, within the same time, in any other post office in the nation, with the single exception of Philadelphia, which is another great *terminus* of railroad communication.

"These facts are presented in no spirit of unkindness towards those to whose management these incorporations are intrusted, but that I have considered it due to our whole people to refer to this subject, as one which will ere long call for National and State legislation, unless a corrective be sooner applied by public opinion."

The grounds of complaint against railroads are two in number, and these are so distinct in their nature, that we shall take them up separately.

In regard to "the extravagant price demanded for transportation upon railroads," the charge is founded upon a comparison between the charge of railroads and stages upon the same main route—"*and that too when the night service upon the railroad is less than that performed in coaches.*" We have in the Post Master General's own words, a proof that the subject is either imperfectly understood or unfairly expressed. It is certainly cheaper to run a stage coach, at night particularly, over a short route than to run a railroad train. In fact, this is the whole secret of the difficulty with railroad companies—the mail service, in most cases, requires them to start at inconvenient hours—viz. at such hours as do not suit the majority of the travelling community. Such companies are not disposed to go out of their usual course unless for an adequate remuneration; their business, particularly upon great routes, is very good, and they need no assistance; stage proprietors are, under the same character of routes, very well disposed to run an opposition to railroads, their passengers would be insufficient for a support, while a moderate compensation for mail service would be enough to pay a small profit, while without it, there would be none at all.

But throughout his report, the Post Master General has no reference to the superior speed of railroads, and the consequent increase in the facility of intercourse. Is it not worth paying even two hundred per cent. more for the privilege of sending a letter from New York to Philadelphia and receiving an answer the same day, instead of writing one day and receiving the answer the next? And even this could not be accomplished in coaches without very great expense. This great oversight has brought out a number of anecdotes of the primitive mode of carrying the mail, which Mr. Granger seems to have had in mind when he made his tariff of charges. We have been told, that within fifty years, the great western mail from Albany was carried by a postman on foot, at what number of miles per hour we are not informed—when business increased the mail was carried on horseback, and soon, in a one horse wagon, and then passengers were taken. Such primitive methods of transport might probably be reintroduced with great saving to the Post Office department. We have seen a notice by Mr. Benjamin Franklin, informing the public that arrangements for facilitating the intercourse between Boston and Washington had been made, by which a letter might be written and an answer received in the short space of three weeks!! instead of six weeks as formerly!

There are cases, no doubt, in which exorbitant demands have been made; railroad companies are not immaculate, neither are stage proprietors, and on reference to former lettings it will be found that the words "too high," are marked opposite many bids for stage service.

The second complaint against railroads is quite as singular as the first. The Post Master tells us that "*the facilities secured by this mode of conveyance for sending letters by private hands very seriously diminish the receipts of the office upon these routes.*" We should like to know what the facilities are which enable passengers upon railroads to carry private letters more readily than when travelling in stages. The Post Master should have said that there was more travelling by this than any other conveyance, that between two cities, for important business, the expense of time was trifling, and that of money not to be compared to the advantage of attending in person to business of any consequence. He should have said, that as the expense of travelling decreases. postage remaining the same, there will be a constant diminution of the post office revenue upon such routes.

With equal justice might the Secretary of the Treasury complain of clergymen, that their influence diminished the revenue derived from the importation of indecent books and prints.

If the Post Master General wishes to keep up with the times, let him bring about a reduction in postage, and he will soon see that such a course will answer far better than national or State legislation, to say nothing about the propriety of his appeal to public opinion.

For the American Railroad Journal and Mechanics' Magazine.

TOLLS ON CANALS AND RAILWAYS—LOW FARES.

I beg leave to call your attention to an article in the Civil Engineer and Architect's Journal of November, 1840, on Mr. Ellet's "Remarks on Railway and Canal Traffic," (published in this Journal some time since, in which the writer undertakes to show that the principles there advocated, are "fallacious and unjust," and to suggest the propriety of your publishing this article, either wholly or in part, as you may think proper. It is not my intention to offer any remarks or opinions on these objections to Mr. Ellet's theory, but, "while up," will take the opportunity of giving my views on the at present, very popular theory of low fares on railways.

This theory may be said to rest on the following proposition—that by reducing the fare, the business will be increased. Now this argument is virtually an assertion, that a large amount of trade already in existence, is kept from the railway by the too great cost of transportation, or that by diminishing the price of haulage, a large additional business could be created. Both these positions are undoubtedly true, in some cases, but that they are generally true, more especially in the United States, is what we have not been convinced of, from our own experience or observation, by the perusal of any remarks which have fallen under our notice. The rates of fare are established by the proprietors of public works—generally men of business, consequently cautious—and, to induce them to lessen existing rates, it is necessary to show, that, by a given diminution of fare on certain articles of transportation, a corresponding increase in the quantity of these articles may be confidently anticipated. This can only be done by means of an intimate acquaintance with all the details of the trade in these particular articles—a knowledge to be acquired only by attentively studying all the circumstances which influence the production or consumption of the articles under consideration, in other words, local knowledge. The objection is not to the principle—which may be applicable to all works, varying, however, immensely in the extent of its application—but that no general rates can be given, by which the most advantageous rates for the proprietors and the community, can be determined. Perhaps every reader of this journal can refer to some public work, on which a diminution of even 50 per cent. in the fare, would add little to the business, and to others, where he is convinced that a very considerable reduction in the cost of transportation would not only increase the trade in a much greater ratio, but would even swell the dividends, and in some extreme cases, render investments productive which are now profitless. Among the first, will be found works whose principal income is from the "through"-business, forming a link in some great thoroughfares, such as the Providence and Stonington, and most of the railways in this State; also works of a local character, such as the Boston and Lowell and Paterson, N. J., railways, which derive their revenue almost exclusively from the manufactories. Now the cost of transportation, is of course, an element in the cost of the fabrics of Lowell and Paterson, but so small a one, that it is difficult to believe it capable of influencing the construction of new, or the extension of existing establishments. On the other hand, the consumption of coal is limited to its present extent by its exorbitant price, and that price is principally owing to the great cost of transportation, hence a vast increase in the consumption would be the immediate consequence of the production of that necessary of life at a reasonable cost. It will be urged that all the links of a thoroughfare should belong to the same company or State; but these chains of communication extend in many instances over several States, and even when in the same State, as in the case of the seven distinct railways which will in a few years unite the Hudson and lake Erie, it will be found impracticable to condense the seven corporations into one, owing to the vast difference in the value of the several links, unless the State step in and "assume the mantle" of Engineer-General of railways as well as of canals. This policy was strongly advocated by a prominent member of the assembly of New York, during the last session, and at the same time he very candidly admitted he did not see where the State was to halt in this career, if once entered on. This appears to be the only mode of introducing a regular system of rates of transportation throughout the State, though whether this would be eventually to the advantage of the public, is a very different position, and much more important than any discussion on rates of toll.

Supposing it to be ascertained that a decrease of toll will lead to an increase of traffic, on a certain railway, the great difficulty is to determine the charge which will command the greatest amount of business, and still yield a reasonable profit to the stockholders. In endeavoring to draw additional business to a railway by reducing the tolls, it is absolutely necessary that the reduction should be sufficient to effect that object, and a diminution of 10 per cent. may be as injurious as a diminution of 30 or 40 per cent. may be advantageous to the proprietors. Experience shows that when the passage from Albany to New York is less than $2, there is no corresponding increase in the number of passengers. The fare is now only $1, with the best and most extensive accommodations ever known, and there can be little risk in asserting that the number of passengers now is not nearly twice that when the fare was $3, several years since, including the natural increase on this great thoroughfare. The general impression appears to be, that $2 is sufficiently low to command very nearly all the travel, and thus afford the public all reasonable accommodation, and the proprietors a fair return for their investment. No one, however, supposes that one or even two dollars, would yield any profit on lake Champlain for carrying passengers 150 miles, from Whitehall to St. John's, though boats may be run much more cheaply on that lake than on the Hudson. Railways differ from each other in their objects, as widely as do these steamboat routes—the latter are rendered profitable by attentively studying all the peculiarities of their field of action and regulating the charges accordingly, and it appears impossible that the same principle should not apply equally well to regulating the tolls on the former. But how are all these local peculiarities to be allowed for in a general law? The community have a right to expect the lowest charges which will yield a fair remuneration to the proprietors for their capital and risk, and this object, we believe will be attained when the charges on any particular railway are so arranged as to conform to the present wants of the particular community on which that railway depends for its present business, and to vary those charges whenever any change in the business of that community justifies and requires such a measure. As already observed, tariffs of freight are made out by men of business, who are notoriously averse to generalities and abstract propositions, and any system or theory of tolls which is expected to produce any useful effect, must be such as they can clearly see through, tracing effects to causes without any other aid than that derived from their ordinary habits of investigation. In this view, we concur, and consider the difficulties in the way of arranging the most advantageous charges so great, as to render inoperative a complete investigation of the kind and extent of the traffic which the railway is to accommodate, increase or create, what its future capabilities and prospects may be, what risk of rival lines, etc., etc., and if the conclusions thence deduced, agree with any proposed theory, confidence in them may be somewhat increased; if they differ, it is needless to say which will be unhesitatingly adopted. The very object of railways is to facilitate intercourse and diminish the cost of transportation, and their very existence requires that the income should clear expenses, repairs, and renewals, besides yielding a liberal return for the capital invested, as well as for the trouble and risk incurred by those to whose energy and enterprise the public is indebted for their unrivalled facilities; and though believing it to be the interest as well as duty of the proprietors to afford these facilities at the lowest charges, we should still hesitate to assert that the charges on any particular railway were too high, until we knew the cost of its construction, and management, and had studied the nature and extent of the particular trade it was destined to accommodate. W. R. C.

June, 1841.

The subject of finance, although not strictly speaking professional, has attained such importance in the eyes of the community, that no excuse is necessary in offering the following project, furnished by a friend:

For the American Railroad Journal and Mechanics' Magazine.

As an American citizen, I view with a peculiar interest, the present anomalous situation of our monetary affairs in this country, and look with intense anxiety towards the efforts now everywhere manifested among our commercial and productive circles, to direct the eyes of National legislators to this or that plan, having for its object, the creation of a Fiscal Agent of the General government, which may be so constituted as to equalize the exchanges, and restore harmony, reinvigorate enterprise, cherish prudent industry, and by the establishment of a wise system of checks restrain the tendency to wild, erratic, or improvident management of local banking facilities—which has grown up among us within a few years, engendering a spirit of speculation, which, like an epidemic, has spread itself aver every part of our once prosperous and happy country—and left scarcely anything but wrecks of former prosperity—to serve as beacons, warning those who come after us, against the danger of pursuing a like hazardous course.

Numerous, indeed, are the projects which have been already proposed to meet our trying emergency. But as a free discussion of their respective merit is to be expected, most of them have been found wanting in essential qualities—in passing through this ordeal of public opinion, and thus opponents spring up on every side.

Many citizens entertain an idea that it is not within the powers which the constitution confers upon congress, to create a joint stock corporation at all. Others, that it is impolitic, if they have really the power, to create one with a large capital, fearing that it will be impossible for the whole to be filled up by citizen capitalists without creating new difficulties by the sudden withdrawal of monies from other pursuits of industry or enterprise, and deeming it improper and hostile to the true interests of our own countrymen, to permit the majority of such a capital stock, to be taken by foreign capitalists, who, having no other interests in view than the realization of profits expected for the investment of their monies, might thus gain the possession of an immense power, capable of being used to subvert our democratic institutions in case such a wish exists among them. Many knotty points are disclosed to view in a free discussion of these questions, yet the subject itself is of such vital importance to future prosperity, as seems to demand from all experienced, enlightened, patriotic and practical minds, a thorough, careful, and minute examination of the subject, and by free interchanges of opinion, let us endeavor now to perfect a system which shall be consistent with the constitutional principles of our republic, and at the same time afford ample protection against losses to the industry, enterprise, and prosperity of all classes of our citizens. The experience of past years, has demonstrated the fact, that a check connected with the fiscal operations of the government, can (as a National concern,) exercise a very salutary influence in regulation of local banks and bankers, and if free discussions of suitable plans, to attain so desirable an end as the equalization of domestic exchanges, and protection against sudden expansions and contractions of the circulating medium, shall have the effect of bringing our National legislators to a right conclusion, that *true political sagacity* imperatively requires their early action upon this all important business, then I trust they will weigh well the suggestions of practical business men, whose active pursuits, and daily routine of life, afford to them an immense fund of knowledge of essential details, and their experience of *what is wanted* will enable *them*, perhaps, to advance views and plans more susceptible of being reduced to practice, than might be those of professional theorists in political economy.

Allow me to propose a plan of a Fiscal Agent to be created by congress as a guarantee to bill holders, a regulator of local banks, and to be furnished with such powers as may equalize the domestic exchanges.

First. Let congress enact that the paper circulating medium shall only be issued by an institution to be created by the United

States, which institution shall be restricted from any other business than merely the reception of deposites and the emission of bills in exchange therefor, which bills alone shall form the paper currency of the whole of the United States.

Let congress require that every banking incorporation, or private banker, who design to make discounts, to deposite their specie, or equivalent securities, which forms their banking basis, in the custody of the officers of the United States Institution, before they can exercise the right of discounting.

These Fiscal Agencies to be supported by a prorata tax, to be paid by the different local banks throughout the country.

Let the legislature of each State, as well as the congress of the United States, enact that *these bills shall be a lawful tender* for the payment of all taxes, imposts, duties, and dues of whatsoever kind or nature, established, or to be established hereafter, under their respective legislations; which would introduce a currency in paper, that would be current funds all over the nation, and from the character of the guaranty, *confidence in its stability would be unquestionable*, and specie seldom asked for, except for foreign commercial purposes.

REMARKS ON THE MORTAR USED IN ANCIENT BUILDINGS—WITH OBSERVATIONS AND DIRECTIONS FOR PREPARING MORTAR IN A MORE PERFECT MANNER THAN THAT NOW IN PRACTICE.

The great perfection to which the arts have atteined cannot be denied; yet on examining the monuments of former ages, of which many are still to be seen in this country, it does appear that the ancients had some manner of making and using mortar for their buildings, of which our modern artists seem either to be ignorant, or do not choose to put in practice. Although the grand edifices raised under the direction of the artists of the present age, is a proof that our modern masters, by the study of the monuments left us by the ancients, have been enabled to construct buildings vying with their patterns; yet the moderns are still behind the ancients in the construction of buildings with small or promiscuous materials, with that degree of solidity which seems almost to set time itself at defiance.

There is no doubt little difficulty in raising lasting edifices by building immense blocks of solid stone, one upon another—but if we say nothing of the enormous expense of this mode of construction, even where the materials are to be found in the vicinity, there is some consideration necessary when works which require durability are to he constructed, where no large materials can be readily found. Hence the erection of buildings which may be of the utmost importance in a national point of view, as well as to individuals, has to be abandoned, on account of the expense attending the modern plan of construction.

On a careful examination of many of the old castles in this country, it will be seen that the materials which have been used are of the most ordinary kind: and from the manner in which they have stood for such a long period of time, it does most readily occur, that the mortar used in these buildings, has been prepared in a different manner from that practised by modern builders. In fact it will be found that many of these old buildings have been put together with almost every description of stones down to the smallest pebble collected from the bed of the brook, and where no heavy carriages or complicated machinery have been required to construct the most extensive works.

Our ancient bridges and aqueducts all exhibit specimens of the same kind of construction with very small stones; depending therefore on the superior manner of preparing the mortar by which these small materials have been cemented together.

Thus there seems to be an art lost, and in place of endeavoring to recover this art by a series of well conducted experiments, men of genius, and particularly our modern philosophers, seem to have principally in view to bestow their labors in pushing into the world books filled with abstract calculations which they understand only on paper. These calculations are, however, by far too nice, and it is much to be feared that few of the writers could be found to reduce them to practice—and as practical men do not understand them, they are useless to the world. It may be very well for the physician to write a learned prescription intermixed with hieroglyphics, to the apothecary who understands it; but alas! the carpenter and builder have neither time nor inclination to enter into the abstruse analysis of the philosopher. Bred to labor from their early youth, it is only from experience they are accustomed to learn; and it is therefore only from a course of well regulated experiments, described in plain language and simple figures, that the laboring artist's attention can be arrested.

It would, therefore, in almost all cases, be the means of more rapidly diffusing a knowledge of the useful arts, were our seminaries furnished with the means of exhibiting in some degree of experiment, specimens of the various useful arts. For without experience, what is the young engineer who is sent forth to direct the operations of a siege, to raise fortifications, form aqueducts, or construct bridges? It is clear he has yet to learn from the laboring artificer, the essential parts of his business; and thus he is sent forth only with the name, to learn from those of inferior station, who are here found capable of giving instructions from experience, where fine theories and abstruse analysis can be of little avail.

To return, however, to our ancient buildings, where it appears neither time nor labor was lost in the execution. Many of them seem constructed of little else than rubbish thrown together with an outer coating of small stones, or pebbles from the brook, but built with a kind of mortar which appears to have been thin enough to penetrate the smallest crevices, and to form a solid, compact, nay almost an impenetrable body. And if the ruins are considered with the smallest degree of attention, it will convince us that all the secret of this mode of construction, consists in the preparing and using the mortar which has bid defiance to time, and to the tools of the quarrier to remove, after the lapse of ages. Every workman who has been engaged in taking down any of our old castles, will testify that he has always been able to remove the stone with greater facility than he could disengage the mortar.

How differently then must this mortar have been prepared from the very best which is now prepared by our modern builders; for the latter only dries to fall to dust again when broken into. Another of the grand qualities of the ancient mortar is its being impenetrable to water; and, in fact, the aqueducts for retaining and conveying water which are still to be seen, exhibit no marks of clay or other kind of puddle having been used for retaining the water. Therefore, it does appear that aquatic as well as other works, were frequently constructed of very small stones, by the builders of former ages, and that they were in the practice of forming parts of their buildings into cases or *caissons* of planking, by which means the mortar when run in among the interstices of the small stones, was prevented from escaping.

It can therefore be most readily conceived how easily a building of great magnitude may be constructed at a small expense, and that of the most durable and lasting kind, of materials with which almost every part of our country abounds, if we are only careful in the preparation of the mortar with which these materials are to be cemented together.

It does not appear that the ancients used any other ingredients in their mortar than lime, sand, or calcined earth, such as brick dust, when proper sand could not be procured; and therefore, as already mentioned, the whole secret seems to be the manner of preparation, of which some explanation will now be attempted.

It is presumed the fact is well known, that in the burning of limestone, the fixed air which it contains escapes, and the stone by this means loses it weight. It has indeed long been the practice to grind or slack the lime immediately after being burned, and by means of mortar mills, where the extent of the works can afford them, to prepare the hot mortar for immediate use for building or bedding large materials; but, it is a fact well known that this kind of mortar (to say nothing of the great expense of procuring it,) would be useless in ordinary buildings, as the weight of the substance in thin walls composed of small materials, would not prevent the burstings, cracks, and sets, which would take place; nor, from the consequence of blistering, which always happens when mortar prepared in this way, is used; rendering it unfit for plastering either to withstand the action of the weather, or for lining water courses; because it suddenly dries by the evaporation of its moisture, and consequently, immediately gives way to cracks and shrinking.

On the other hand lime-mortar after lying a considerable time in a sowered state, imbibes again the fixed air which was discharged in the process of burning, and when carefully examined in this state, presents a kind of transparent, or rather icicle, appearance, which destroys in a great measure the binding quality, and which, in our changeable climate, rarely or ever has the effect of cementing the building. The latter, however, is the manner in which almost all the lime-mortar is most commonly prepared for building, both from a regard to economy as requiring less time, and also with regard to labor; and, it is more than probable it was by hand labor also, that the builders of former ages prepared their mortar. It is therefore to this principle that observations have been directed, of which the following notice is submitted, and which it is hoped, if properly attended to, will enable those who wish to do so, to prepare and use lime-mortar not inferior to that of the ancients.

Sower together a quantity of lime and clean sharp sand for two or three weeks before being used; work this well and turn it aside, and as the proportion of the lime to the sand, will always depend on the quality of the former, all that is necessary is, to take care (in sowering,) if the lime is of a rich quality, to put one-third less lime into the heap, than it is intended to be built with; and, if the lime is of poor quality, say only one-fourth less. (It may here be observed that in general lime of the poorer quality is best for cementing building). When the lime which has been previously sowered, as before directed, is to be used in the building, or otherwise, it is to be again carefully worked over, and one-fourth of quick lime added in proportions, taking care never to have more in preparation than can be used in a short time; and this quick lime should be most completely beaten and incorporated with the sowered lime, and it will be found to have the effect of causing the old lime to set and bind in the most complete manner. It will become perfectly solid without the least evaporation to occasion cracks, which can only ensue in consequence of evaporation; and this can only happen from the want of proper union between the two bodies. But by mixing and beating the quick lime with the sowered mortar, immediately before it is applied to use, the component parts brought so near to each other, that it is impossible either crack or flaw can take place. In short, beating has the effect of closing the interstices of the sand, and a small quantity of lime paste is effectual in fitting and holding the grains together, so as to form a plastic mass, by uniting the grains of sand which otherwise would not fit each other. This system will apply to lime-mortar for all descriptions of work, whether for building, plastering in the inside or outside of houses, water cisterns, ground vaults, rough casting, etc., etc.

It may not be improper to mention that whenever there is any difficulty in procuring proper sand for building, clay is an excellent substitute; and all that is necessary is, to make it into balls, and burn it, and then pound it like brick-dust, or pozzolano earth. There is no doubt, in addition to the superior scheme of making mortar in former ages, that, when they used only the small, which we see in the ruins of their buildings, they were in the practice of using temporary casings of boarding which they could move from place to place as the building advanced, and which would enable them to grout or fill up with their quick mortar, all the interstices in the successive layers of stones. And, moreover, by having the boarding of their centering for arches and conduits quite close, they were enabled to lay on, along with their stone, almost an impenetrable coating of plaster.

From the foregoing observations, it is hoped, it will be most clearly seen that an easy mode of erecting substantial and durable building is generally within our reach, and that the most inferior kind of stones may be used, providing proper care is taken in the preparation of the lime-mortar with which they are to be cemented together. JOHN GIBB, M, Inst. C. E.

Aberdeen, January 2, 1841.

HIWASSEE RAILROAD IRON.

J. Edgar Thompson has forwarded to us the report of S. D. Jacobs, President of the Hiwassee Railroad, on the subject of the manufacture by the company of the railroad iron. The report is a document of considerable interest, and shows satisfactorily to our mind, the propriety of the enterprise by the company. Gen. Jacobs has, in obedience to a resolution of the board of directors, visited the iron district in Pennsylvania, and after an inspection of the works at Pittsburg and the adjacent country, and the most unreserved and intimate intercourse with the most intelligent iron manufacturers of that district, has been convinced of the importance to the Hiwassee company of making their own iron, and hence he has purchased two steam engines, and other machinery, for commencing the work. The estimated cost to put the entire establishment in successful operation, is $55,000, the whole to be propelled by steam with the use of stone-coal, which the report represents as abundant in the immediate vicinity. We are gratified to see the work of manufacturing iron commenced by this enterprising company, and it is by no means visionary to anticipate, that at no distant day, the eastern district in Tennessee will become as distinguished for its iron manufactories as western Pennsylvania, and in the language of Mr. Thompson, "a Southern Pittsburg" may grow up along the line of the Hiwassee Railroad. We take the liberty, without the consent of Mr. Thompson, of giving his entire letter accompanying the report, which affords a theme worthy of much reflection to all who feel an interest in our own great improvements.—*Augusta Chronicle.*

Greensboro, June 7, 1841.

Dear sir—I send you a copy of the report of Gen. S. D. Jacobs, President of the Hiwassee Railroad company, in relation to the manufacture by that company of their railroad iron. The scheme is shown to be entirely practicable, and when carried into effect, will enable the company to procure their iron at one-half the cost it could be delivered in that region from England. And instead of draining the country of its capital, their funds will be disbursed at home, furnishing active employment to the industry of East Tennessee.

This matter is worthy the attention of those having charge of our great State work. If no other object than its ultimate effects upon the prosperity of the region at the northern terminus of their enterprise was considered, it should meet with all the encouragement they are authorised to give it. I look, however, upon the successful accomplishment by this company of their new undertaking, connected with our system of internal improvements, as destined to produce more beneficial results upon the prosperity of this section of the Union, than any scheme that has yet been submitted to the consideration of the southern people, and will go farther towards the consummation of their commercial independence.

From the facts stated in the report, it is evident that the establishment about to be erected by the company, will be the nucleus of a southern Pittsburg, the manufacture of which will be distributed by our railroads now in progress over Alabama, Georgia, and Carolina, from the mountains to the sea board. The abundance of coal, iron, and limestone, and the cheapness of bread stuffs in this region, together with the facilities of communication which will shortly be opened to it, must render the success of the enterprise beyond a doubt, producing in its train results with a rapidity as astonishing to those who have not reflected on the subject, as they will be beneficial to the whole country. Yours, etc., J. E. Thompson.

The Croton Aqueduct.—by Oliver Smith.—The city of New York is soon to be supplied with water from the Croton river, a mill stream that rises among the highlands of Westchester and Putnam counties, in the State of New York, and, winding its way in a southwestwardly direction, discharges from thirty to fifty millions of gallons daily into the Hudson, a few miles north of Sing Sing, a village in the same county of Westchester, that has just been spoken of. Across the first mentioned river, and about six miles from its month, and nine miles by the road, in a northeastwardly direction from Sing Sing above named, a dam is now being constructed, the top or lip of which is to be 166 feet above the high tide water at New York; and from the pond thus to be formed, the water is to be conducted upon an inclined plane, (and of course it must be so conducted, if conducted at all, for no locks are admissible in such a case) commencing at an elavation of 153 feet above the tide water aforesaid, and descending generally about fourteen inches in a mile for the distance, including the windings, and its course is very serpentine, of about 33 miles, to the Harlem river, where it will be 120 feet above the same tide water of which we have already spoken; and furthermore, it is still to be continued in various modes, across that river about 9 miles, first to a receiving reservoir which is to hold 158,000,000 gallons, and thence through iron pipes to a distributing one which is to hold 19,000,000 gallons; the latter being something like three miles to the north of the City Hall of the same city above mentioned; and thence it is to be sent again through iron pipes to the houses and other places where it may be required for use. And of this work which is now nearly complete the expense is likely to be, according to the recent message of the Mayor, about $12,000,000.

The region of country through which this aqueduct passes is very uneven, and notwithstanding every practicable effort was made to avoid hills and valleys in locating it, still many of both were found in its way, so that in constructing it, as may be supposed, several tunnels and many deep cuts were made, and many low places were raised, with earth and masonry, to its level.

The aqueduct proper, or the channel in which the water in this case passes, is constructed thus:—Two walls are erected of common stone masonry, and lined upon their inside with one course of bricks, which rest upon other bricks that are placed edgewise in the form of an inverted arch of 9 inches in depression; and these walls, thus constucted of stone masonry and brick lining, are 6 feet and 9 in. apart from the inside of the one to that of the other, and 2 feet 8 inches thick at the bottom; and slope upward 4 in. upon each side to the height of 4 ft., so as to be 7 feet 9 in. apart from inside to inside and 2 feet thick at the top; and upon them is a semi-circular arch that is 8 inches thick; and above the whole, when completed, the loose earth is thrown to the depth, or rather altitude, of about 4 feet, to prevent the water which is to run below it from freezing during the winter season. It is not intended that the water shall rise in this case above the spring of the arch above, or top of the side walls of which we have spoken, and which, as we have already said, are 4 feet high; and adding 6 inches as an average for the 9 inches in the depression of the inverted arch that has just been mentioned, we shall have $4\frac{1}{2}$ feet for the height of the water in this aqueduct; and its width being $6\frac{3}{4}$ feet at the bottom, and 7 5-12 feet at the top, will be equivalent to 7 feet; and thus we shall have 31 1-2 or 32 feet at the most for the area of the end of the stream.

Had this aqueduct been constructed wholly of bricks, its form should have been cylindric like that of an ordinary sewer, and the ring or zone should have been one foot thick; but such a structure would have been much more expensive, and no better than might have been the present one with a little variation, which we shall now point out.

In the 2d volume of Hutton's Mathematics, it is shown how piers and walls should be constructed, in order that they may support a given arch; and calculations made pursuant to this demonstration will indicate that the walls of which we have spoken above should have had about *eight* inches more of leverage at the bottom; that is, had their base extended *twelve* instead of *four* inches outwardly beyond their top, their exterior sides thus sloping upward, and their other parts remaining as the same now are, they would have snpported the arch and the earth above them; while, as the case actually is, they do not do so, but are pressed with considerable force upon the earth which is thrown up against them. And no harm, it is true, will result from this circumstance where the aqueduct in question is wholly beneath the surface of the ground, for there its walls may, and doubtless have been, actually prevented from spreading in the least, by having the earth that is thrown in between them and the bank beyond trodden and beaten down firmly and compactly; but where there is an embankment the same is not so easily effected. The loose earth that is in this latter case thrown up against the walls, yields more or less as they are pressed upon it; and contractors and overseers upon this work have told me, that in consequence of the spreading of these walls, many wide openings appear occasionally in the arches above and below, and that they have been obliged to stop the same, and sometimes more than once, with mortar, in order that their work might bear inspection.

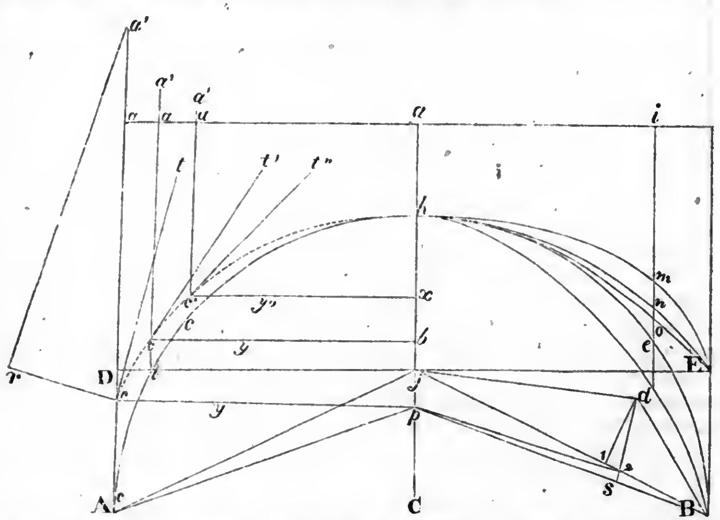
This, however, should not be so. A little science, aided by what would have probably been no additional expense at all, would have built those walls so that they would not have spread in any place, whether in case of an embankment or deep cut; while, for the want of that science, the work in question may give way, and no body knows how soon; and its engineers have no excuse for such ignorance, and especially among the many schoolmasters who are every where abroad, and gladto instruct for a respectable living.

We perceive that from the bottom of the aqueduct to the top or lip of the dam is 13 feet; and that from the highest point to which it can ever be desired to have the water rise in the aqueduct, to the lip of the dam, is 8 feet, if the engineers state correctly; and hence we can readily imagine how a sluice may be constructed that will throw the water into this aqueduct with considerable velocity.

A mile of this aqueduct will contain about 1,250,000 gallons; and it is supposed that the present population of the city will require 7,000,000 gallons of water a day; and hence, if the water fills the aqueduct, and moves at the rate of about six miles a day, it will be sufficient in quantity for the present.

The Croton river is calculated to yield, when rather full than otherwise, about 50,000,000 gallons of water a day; and this, with a velocity of something less than two miles an hour, would all run through the aqueduct; so that as to the dimesions of this channel I have no criticism to offer at present.

Of the structure in question, some of the arches that occur over roads, ravines, etc., are elliptic, while the rest are circular ones; and those for the bridge which is now being erected in the same structure over the Harlem river, are intended, according to the plan which the engineers publicly exhibit, to be semi-circular. These arches are to be 15 in number; eight of them are to be over the river, and the other seven will be over the low ground which happens to be found upon the north-east or Westchester side of this river. Of the arches over the river, the piers from centre to centre are to be 94 feet apart, and of the other, the piers measured in the same way will be 57 feet apart; making a distance of 1,151 feet for the whole bridge, and the same is estimated to cost about $9,000,000.



A B, the span of the large arches, is to be 80 feet, and of the small ones 50 feet; and C *h*, the elevation in the one case, is to be 25 feet, and in the other 40 feet of course, as we are to have semicircles; and consequently, of the large arches the piers will be 14 feet thick, or in the direction of the bridge at the top, while those of the small ones will be only 7 feet there in that direction.

In order that vessels may pass conveniently upon the Harlem river beneath this bridge, the Legislature of the State have directed that the soffit beneath the crown of the large arches at *h*, shall be at least 100 feet above the surface of the water below it; and this altitude, it will be borne in mind is about 20 feet below the level of the aqueduct; and to avoid the expense as well as the weight of this 20 feet of structure, it is proposed to conduct the water across this bridge in iron pipes, to be laid in the form of an inverted siphon; that is, the water will descend into them upon the Westchester side, and rise again to its proper level upon the New York side of this river, and thus pass on to the city; and in the same manner too, though the circumstance may not be exactly in our way just now, it is to be conducted across a wide and deep valley a little further downward at Manhattanville.

These pipes are to be three feet in diameter within; and of course four of them, the number proposed in this case, will present an area at their end of only about 28¼ feet, which is something less than the terminal area of the previous portion of the aqueduct, which we have just shown to be about 32 feet. However, in a recent report of the chief engineer of this work, I perceive he proposes to give the water a fall of two feet in passing through these pipes, a circumstance that will doubtless fully compensate for their deficiency in dimensions. But still, if this work were mine, I should increase their diameter, and thus reserve the two feet of descent for the distributing reservoir.

If these pipes were laid close together, they would cover a space of only about 12 feet in width; but in order that one piece may be conveniently and properly joined with another, it will be necessary to spread them so that they will occupy a space about 15 feet wide; and to prevent the water that will pass through them during the winter season from freezing, it is proposed to have about four feet of earth upon every side of them; so that on the whole, this bridge must be 26 feet wide, and have an extrade of 12 feet in altitude above the crown at *h*. The spandrel walls, which are to be two feet thick, are to be carried up to the height of *sixteen* feet above the same point at *h*. Here, then, we have two walls, 2 feet thick, 4 feet high, and 1151 feet long, equal to 18,416 feet of solid masonry, for which a light cast-iron railing should be substituted; and it will be readily perceived that this latter guard would be proper, in order to prevent accidents to persons who will naturally visit this work from time to time, and often in crowds.

I observe that the foundation of the piers for the large arches is 26 feet thick, or in the direction of the bridge, and 36 feet wide; but this is suddenly contracted to 20 by 30 feet, which may be considered as their real base; and their height from the bottom of the river, which we shall suppose to average 20 feet in depth, is 80 feet; so that it will be sufficiently obvious without any calculations just now, that none of these arches will be able to stand alone. Should either of them fall, the whole 15, including all the piers, would follow it and thus constitute a dam across the river, whose navigation so much expense is now incurred to preserve. But this should not be so. Such a work will be a disgrace to the 19th century. The scientific observer, associating the idea of top-heaviness and tendency to fall will almost shudder to look at it.

The hances above *d* are intended to be filled up with masonry that will be two-fifths cavernous; and of course its specific gravity will be about the same as that of the earth and the water including the pipes above it; and hence, we have the simplest case for equilibrating, according to the well known formula to which many contributed, but which seems to have been generalized and completed by Hutton. It is true we have two extrades here. Upon the edges of the arch we are to have one of 16 feet in altitude; and in the centre, another of 12 feet from the crown *h*; but from actual calculation I find that 13 feet may be taken as an average extrade in this case, without any sensible error; and besides, the intended parapet walls above *a a* should not be made.

Applying the formula above alluded to, we find that if the space B *e h d* B is filled up like the rest above it, the line of pressure or thrust *h d* B commencing at the crown, will be so situated below the circular curve, that if the line *i d* is drawn perpendiculary downward from the top of the extrade *a a i* to the line of pressure in question, and through the place where the same is the farthest in a perpendicular direction from the circular curve just mentioned, the distance *i d* will be 100, when that of *i e* to the semicircle already referred to is 80.

Now let us suppose the piers to be raised about 20 feet higher, to D and E, and then we shall have an elevation *j h*, of 20 feet; and in this case, the space E *o h n* E being filled up like the rest above it, and the line *i o* drawn as before to the line of pressure, the same *i o* will be 100, when *i n* to the circular curve is 93; and this arch would be as good for the purpose in question as the other will be; for any concussion that would throw it down would be likely to destroy one of double its elevation and of the same span; and thus we get rid of a large mass of masonry between the curves B *d h* and E *o h*, which for all the arches in question would be worth many thousands of dollars.

If the large arches are semicircles, and if the top of all the piers both of the large and the small ones are brought, as good taste will require, to the same level, it will follow that a large amount of masonry & filling will be necessary upon the small arches, to the amount of 15 ft. in altitude, more than will be needed upon the large ones; and hence, by adopting for the latter an elevation of only 20 feet, we shall be making a great improvement, besides dispensing with the wall upon each side, of which we have already spoken.

Along the line of pressure B *d h* in the one case, or E *o h* in the other should be placed the vousoirs or arch stones; and thus we should have the arch of *equilibration*, which would be pressed in all places alike, and have no tendency to rise up or sink down at one point more than at another.

If the vousoirs are placed along the circular curve B *e h*, the space B *e h d* B not being filled up like the rest above it, then the line of thrust will pass above B *e o*, in the direction *h c' c'* etc., which is represented by the dotted curve on the left, but which is not intended, be it remembered, as a continuation of the circular curve E *n h*.

The equation or locus of the curve *h c' c'* etc. is probably no where given, though it may be readily obtained as follows:—Call $r c' = a h = 13$ in this case, and $a' c' = a c = w = 53$, and the angle at *r* a right one, and *t c' r* being also a right angle, that of *p c' t* will be found to be 73°, the natural tangent of which, radius being 40, will be 173. Now call $h p = x$, and $p c = y$, and the tangent in question will be $\frac{dx}{dy}$; and in the second volume of Hutton's mathematics, page 501 of the edition before me, it is shown that this tangent increases as the weight $w = a' c' = a c$ does in passing from the crown at *h* to *c' c'* etc., and thus to the spring; hence we shall have $dw = C \cdot d\left(\frac{dx}{dy}\right)$; but $w = 13$ in this case, when *x* and *y* both equal 0; and therefore, $53 - 13 = 40 = C \cdot 173$; or $C = \frac{40}{173}$; and thus $w - 13 = \frac{40\,dx}{173\,dy}$; but $y^2 = (40)^2 - (53 - w)^2$; or $dy = \frac{53dw - wdw}{\sqrt{106w - w^2 - 1209}}$; or

$$\int \frac{66wdw - w^2dw - 689dw}{\sqrt{106w - w^2 - 1209}} = \frac{40x}{173}.$$

Of this equation, the left-hand side may be integrated in three distinct series; but the numerical calculation thus indicated are formidable enough, and may not be soon made. By taking $y=1, 2, 3$, etc., successively, and thence obtaining the corresponding values of w however, we can ascertain the respective angles $x\ c'\ t''$, $b\ c'\ t$, $p\ c'\ t$ etc.; $p\ c'$ being an ordinate and $c'\ t$ a tangent to the curve. But however short we may take y, as long as it has any assignable length at all we shall always bring the curve $h\ c'\ c'$ etc. too low down or too near the circular one $h\ c\ c$, etc.: and unless y is taken very short indeed, the circular curve will prove to be the *upper* one of the two. However, in an arch of almost any given curvature, whether circular, elliptic, cycloidal, parabolic, or hyperbolic, whose extrade is of a uniform specific, gravity, and raised much above the crown and level upon the top, the line of thrust will pass above the curve; and if a row of vousoirs is placed along this curve, another one should be placed above it in the line $h\ c'\ c'$ etc. of thrust; and hence we perceive that it is merely by *accident* that such arches stand. If the masonry along the curve $h\ c'\ c'$ etc. is strong enough to be a substitute for vousoirs, very well, the arch will stand; but if it yields, as it always does more or less, the crown of the arch will settle down, and the hanches will rise up; and if the whole arch dees not fall, no thanks are due to the architect or the design.

The elliptic curve $h\ m$ E is obviously as far from equilibration as the circular one is; and in all semi-peripheries, whether of a circle, an ellipse, etc., the tangent of the angle $x\ c'\ t''\ h\ c'\ t'\ p\ c'\ t'$ etc. becomes infinite at the spring or top of the piers, and therefore the weight or w will be so there too; but in the flat arch it never becomes anything, and consequently the thrust in such cases is always horizontal like that of a wedge; and even in the proper arch the principle is the same; for $a'\ c'$ must effect a pressure in the direction $r\ c$ toward the curvature, equal to that of $a\ h$ at the crown, and this is analogous to a blow upon the head of a wedge; and the remaining force of $a'\ c'=a\ c$ is in the direction $t\ c'$ upon the pier and similar to the horizontal thrust of a wedge; so simple is this subject, and even dynamics generally, when properly understood.

Persons who ought to know better tell us about equilibrating an arch by giving a certain form to the vousoirs. Let us look at this a little. The line d 1 being drawn at right angles to B j, the vousoirs B d 1 and $j\ d$ 1 will have no tendency to slide upon each other; and so in all cases the junctures of the vousoirs should tend toward the centre of the curvature of the line of thrust in an arch, or so as to fall at right angles to a line drawn from one juncture to another, when straight bars are put together end to end, as B $d\ d\ j$, j A. If the vousoirs are in the form, however, B d 2 and $j\ d$ 2, they will have a tendency to slide upon each other, though their mutual friction may prevent actual sliding.

Now draw B p perpendicular to d 2, continued to s, and then alter the intrade or line of thrust to B 2, 2 p, p A, and the vousoirs B 2 s and p 2 s will have no tendency to slide upon each other; but this and all other variations of the intrade will require a corresponding variation of the extrade; and those who tell us about making the same extrade suitable for any intrade whatever, merely by giving what they call the "*proper form to the vousoirs,*" talk very foolishly, to say the best of them; and Hutton and Gregory speak of them with much contempt.

It is equally foolish to attempt to equilibrate an arch in an experimental manner, by hanging weights upon a chain that is attached at both ends so as to hang loosely, and thus to form a curve. The thing is wholly impracticable; for there is only one chance among an infinite number that the experimenter will succeed in his efforts. In short, as Hutton and Gregory, and many others assure us, there is but one practicable method of equilibrating an arch; and that is, first, to know the extrade, span and eleuation, and from thence to calculate the line of thrust, and there to place the vousoirs. The operation is simple and easily effected; and it is surprising to me, at least that so few understand it. Many who pass for good dynamicians will preach a long lecture about a certain "*friction,*" which none, as they contend, but the practical builder can possibly appreciate. As to this "*friction,*" however, I have just said all substantially that is to be said about it; and if those who pretend to be able to think cannot understand it, how can those do so who never think at all?

Again, we are lectured about cutting the vousoirs *properly.* Upon this point, too, I have just stated all that the practical builder or any one else understands or knows, and all that exists; and if those who call themselves dynamicians do not comprehend it, I should like to know what they do comprehend.

But I am reminded that circular and elliptic arches are found to stand. True, they do so generally, though they sometimes fail; and I have just given the reason why they do either. How foolish it is to place the vousoirs where they will be of no use whatever, and then to substitute loose masonry for them where the true ones should be? But the peasant would persist in putting a stone at the mouth of his bag, to balance the grain at the bottom of it, whenever he had occasion to carry that grain at all, because his ancestors had done so before him; and equally bigoted, ignorant and foolish are mechanics now in erecting any arch but the one that is calculated from the span, elevation and extrade.

If it is true that a circular or elliptic arch over a door or window in the side of a building, is just as good as the calculated one; and that, too, because the masonry, where the line of thrust actually passes, in such a case is equally firm as is that which consists of vousoirs; but the same is not generally true in the arch of a bridge.

Let the large arches under consideration be divested of the parapet walls of which we have already spoken; let them have a moderate elevation, and be equilibrated; and let the piers upon which they are to stand be extended to 40 feet at their base, and be contracted to 6 feet at the top, in the direction of the bridge, and let them be three-fifths cavernous; and any two of them will support the arch that is to rest upon them. Thus constructed, their thickness would be equivalent to 23 feet; while that of those which are now being erected is 17 feet. Three-fifths of the latter is $10\frac{1}{5}$, and two-fifths of the former is $9\frac{1}{5}$. Thus my piers would contain less masonry than will those which are now intended. Making mine one-half cavernous, their solid contents would be to that of the intended ones as $11\frac{1}{2}$ to $10\frac{1}{5}$. But I should have 1524 feet of solid masonry for each pier from the parapet walls, for which I have proposed above, to substitute an iron railing, and this would enable me to make my piers about as solid as the intended ones are to be.

Again, placing the vousoirs where they should be, along the line of thrust in these arches, I would obviate the necessity of all that masonry which is intended to be put upon the hances and top of the piers as a substitute for vousoirs; and thus by putting loose earth, or nothing at all in its place, I would save in each of those arches about 10,000 cubic feet of solid masonry, which would be equal to about one-half of one of the intended piers! Look at this! What pains are taken to make the piers in this case slender, and the arches heavy—uselessly, ridiculously, nay even frightfully heavy!

But again, have one pipe of about $6\frac{1}{2}$ feet in diameter, instead of four that are each 3 feet in diameter, for conducting the water across this bridge; and then the arches in question, and consequently the whole structure, piers and all, may be reduced from 26 to about 15 feet in width—nearly one-half! and even this pipe would have as much earth and stone at its sides as will the exterior onesin the plan proposed. But this is not all. Instead of surrounding this pipe with earth to the thickness of 4 or 5 feet: inclose it in an airtight case: and then it will not be necessary to make this bridge more than ten feet wide for one foot in thickness, if confined air will prevent the water in question from freezing. We all know this to be so and it is *criminal* to pretend that we do not. We ought to raise our voices in defence of science, which is treated with so much contempt in this case. Any fluid, whether liquid or gaseous, will take caloric very readily from any substance with which it comes in actual contact, and will yield the same again with equal readiness to any substance with which it happens to meet; though it radiates or emits caloric very slowly, if at all. It is a good transporter, in case it has its liberty, but a bad radiator of caloric; and hence, if properly confined, it becomes a better insulator of caloric than is anything else.

No other use can ever be made of this bridge than to conduct the water in question across it, and for this purpose solely should it be erected. The piers should have a large base and a small top, and be very cavernous. Upon them light arches should be placed about ten feet wide, and upon these arches should be laid an iron pipe about $6\frac{1}{2}$ feet in diameter within; and this pipe should be inclosed in an air-tight brick case, whose walls should be only eight inches thick; and one foot is distance enough for their inside to be from the pipe. And the water thus protected could never freeze while passing across this bridge. But as a further precaution, I would build an oven in the chamber which is to contain the influent water upon the Westchester side of this river, and in this oven a fire could be made during cold weather, and thus communicate all its caloric to the water; but no such fire would ever be required. And thus we could have a bridge with equilibrated arches that would stand alone, for less than one-half of what it will now cost for one with arches that will not be equilibrated and will not stand alane! But in case of an earthquake, or a small failure in its materials, it will dam the river, and cease to bear water to this city. And why should we pay $900,000 for a bridge in this case, when we can have so much better for about $300,000?

Stones of all kinds, it is well known, are subject more or less to disintegration and decomposition; and that it is within the sphere of possibilities that some one of these arches may fall, and that too within a few hundred years; and every one will readily imagine that if such a catastrophe should occur while human inhabitants remain upon this island, they will look back and wish that the work in question had been differently constructed.

We should not now, in the nineteenth century, put up such a bridge, and especially when the proper one can be made for less than half the money. To do so is an outrage upon the science of the day. Future generations will think we were crazy, for they will be certainly aware that we ought to have known better.

Mr. Frost, a very ingenious mechanic of Brooklyn, N. Y., has suggested another method for building this bridge; "Have no arches or pipes; but instead of them, lay from pier to pier a trough made of *cast* iron plates. These plates should be 10 feet long, 6 feet wide, and 1½ inches thick; and they might be put together very firmly, end to end, without any *wrought* iron fastenings; and the side plates thus fastened; and standing as they would be, edgewise, would support the stream of water that would pass between them. But this trough might be braced with cast iron bars running to the piers; and let it be inclosed in another one made air tight; and this would add its own strength to the first, and prevent the water in the same from freezing. In this case the piers should be just wide enough apart so that any vessel might pass conveniently between them, and should be raised 120 feet, to the level of the aqueduct. They should be hollow and light, like a shot tower, though their base should be large enough to enable them to stand firmly, and especially in the direction with the river: and they might be bound together with bars of iron, running up endwise in tneir sides, so that they would never break off; for we would not have their crust or rind more than two feet thick."

This would be certainly a very cheap and permanent method of conducting the water across the river in question.

INVENTION OF THE SELF-ACTING CLEANSING MACHINE FOR THE PREVENTION OF PRIMING.

In a very favorable review of this work in the Civil Engineer and Architect's Journal for December, 1837, it is properly stated, as a well known fact, "that the enginc primes in proportion as the water is dirty, and the remedy is to empty the boiler and clean it out."* So perfectly true is this with respect to boilers under ordinary circumstances, and so great are the evil consequences generally arising from having foul water in boilers, that the great cause of complaint among all who have been concerned with the management of engines, has always been the difficulty of resorting sufficiently frequent to the operation of cleaning out. Persons who have only a superficial acquaintance with the steam engine, and who treat the boiler merely like a large culinary utensil, are apt to conclude that, provided the boiler is occasionally swept out, so as to prevent any adhesion and consequent burning out of the iron, nothing more is needed; but the experienced operative knows very well, that, if his engine be heavily loaded, and his boiler supplied with the ordinary water to be found in large towns, which usually contains a greasy or slimy kind of dirt, then, instead of the boiler bottom being in any danger of burning out from this cause, he will seldom find much dirt upon the boiler bottom itself, but by far the greater portion will be found sticking up against the roof, or inside of the top of the boiler, and against the back end, but always *above* the surface of the water. We frequently find that the dirt in this manner spread over a very considerable area to the thickness of a couple of inches, and mnch thicker in some particular places, such as in the angles and about the straps to which the stays are attached.

Being impressed with the importance of attending to the above considerations, as regarding obstacles which seemed to lie at the root of all further improvement in the steam engine, and besides being convinced by repeated experiments, that in all cases there is a great saving in fuel and tallow by cleaning out the boiler once a week instead of once a month;† we became of opinion that if means could be devised for cleaning out a boiler *daily*, or oftener if needed, without wasting much hot water, a great desideratum would be accomplished. With these views we commenced, nearly a dozen years ago, the solution of the following problem, namely:—How to clean out a boiler without having it emptied and without stopping the engine, and thereby to supersede as far as possible the disagreeable necessity of sending men inside for that purpose? Now this was not a question to be easily answered off hand, neither was its direct solution to be evaded by some lucky thought, such as contriving a particular shape of boiler for the purpose, but the invention, to be useful, must be applicable to all sorts of boilers. Consequently there appeared to be no method of procedure so likely to be successful as the old one of the mathematicians in all cases of difficulty, namely, that of *trial and error*; accordingly that was the method resorted to on this occasion; and as might be expected, although success was eventually sure, it came slowly, and in August, 1829, the first complete cleansing machine was applied to a 20 horse boiler belonging to Thomas Marsland, Esq., M. P. for Stockport.

Of course the first machine made, as we expected at the time, only partially answered the purpose of keeping the boiler clean, but it did so sufficiently well to completely prevent the priming of the engine, and was so far effective in other respects that the boiler was found to be cleaner at the expiration of thirteen weeks continued working than it had been before at the end of two. From the continual and gradual improvement upon almost every new machine that was made during the succeeding seven years,

* The Civil Engineer and Architect's Journal, Vol. 1. pages 37, 121, and 178. London, 1838.

† A period of *three days* was recently found to be the utmost limit that could be allowed, and at a factory near Stockport, without the engine priming, although there were two 50 horse boilers to one 70 horse engine.

accompanied, as may be supposed, by not a little labor and many disappointments, the apparatus was at last rendered perfect. Indeed for the last three years, so far as it is required to free a boiler from mud, sand, clay, salt, or *loose* sediment of any kind whatever, we can pronounce the cleansing machine to be quite perfect and admitting of no further improvement. There are at this time, 1839, nearly one thousand of these machines in use, principally in Lancashire, Yorkshire, Durham, and Northumberland, so that any considerations in the construction of a boiler, with a view to the necessity of a man going inside to sweep it out, may be safely discarded.

Mr. Marsland of course deserves the credit of being the first among the very few manufacturers who were willing to allow the apparatus to be tried at all, and he has, or rather the firms with which he is connected have, now, at their extensive cotton and print works, no fewer than sixteen of these machines at work, which have been made at various times during the progress of the improvements. This gentleman was also the first manufacturer in the district to try Mr. Samuel Hall's patent method of condensing without injection, which by enabling the boiler to be supplied with distilled water, also offered apparently the only plausible means of preserving the boiler. The plan, however, as is well known here, totally failed, as it was given up, after long and very expensive experiments at Messrs. Marsland's Portwood mill, in Stockport.*

The first cleansing machine for a locomotive boiler was made for Messrs. Galloway, Bowman and Glasgow's engine, the Caledonian, belonging to the Liverpool and Manchester railway company, in 1833. This engine was the first locomotive that was made with the boiler oval in section, and was worked with great success for some years as a bank engine on the above railway. The first complete machine for a marine boiler was made in 1835, and the apparatus was fully proved to act well in the city of Dublin company's steam packet the Shamrock, in the summer of 1835; this vessel we believe being the first which had the cylindrical marine boilers with numerous tubular flues, which boilers, we may here remark, are the only kind that are capable of bearing any considerable pressure of steam, without which the advantage of working steam expansively is, at the best, questionable in *commercial* steamers.

We are thus particular in stating the above facts, because since the publication of the first edition of this essay we have had sundry applications from various quarters, both in this country and the continent, respecting the cleansing machine; and it may have some trouble to parties at a distance in being informed, that the cost of the machine in Manchester is from 12*l.* to 15*l.* It has been entirely uphill work to bring this invention to its present state of perfection, while the author acknowledges that his perseverance was not a little stimulated by many first-rate scientific mechanics pronouncing his task to be hopeless. He would advise his brother mechanics who may have similar obstacles to encounter, to pursue the object they may have in view, and equally avoid having any connection with either *patents* or *patrons*, unless the latter make their first appearance in the shape of customers. Many of our applicants have expressed great surprise at not having heard of the apparatus previously through some of the scientific publications, we can assure them, that if they delay the adoption of improvements until they are sanctioned by the approval of the editors of scientific journals, they may safely calculate on being at least ten years behind their brother manufacturers in this country. The most successful

* This was Mr. Hall's second patent for the same object; his first had been previously tried at Mr. Sherratt's foundry, in Manchester.

manufacturers in Lancashire do not generally look into books for improvementi in machinery, and still less do they consult the advertisements of inventors and patentees for that purpose.

No doubt the best policy of the mechanical engineer in regard to the propriety of adopting improvements in any kind of steam engine apparatus, is that ascribed to Mr. Field in his fitting up of the Great Western steam-ship, who, it seems, preserved "a prudent mean between the rejection of all untried expedients on the one hand, and the rash adoption of crude projects on the other."* But it is no very easy matter, for even the best informed engineer, to hit this happy medium;—very great talent, as well as much labor and research, must be necessary to enable him to avoid being frequently egregiously deceived by some of the immense multitude of inventions that are constantly offered to his notice; among which it may also happen to be far from being an *uutried* scheme that is entitled to be considered a *crude* project. The most crude and clumsy of projects, and those which have been tried and laid aside scores of times, are constantly being revived and re-patented; and when brought out in connection with a long purse, are almost sure to take at first; while the real mechanic who makes useful practical improvements, may struggle in obscurity for a lifetime, unless he resort to that advertising quackery which gives to the worthless inventions of his rich competitor nearly all their eclat. It is surprising what a progress a clever monopolising patentee will make, in a very short space of time, with a railway or steam navigation company, as compared with his almost uniform want of success with the enterprising cotton spinner; who rarely deputes any subordinate agent to *think* for him on the expediency of adopting any new plans, however well such agents may be able to manage the old ones.

A Yankee Boring Iron.—From some source, which that paper says "authentic," the Philadelphia Chronicle learns that a person in Marblehead Mass., has invented and put into practice a machine by which he can descend to the bottom of the deepest water. Attached to this sub-marine article are several augers, by which the person in attendance can in a few minutes bore a hole through the bottom of the strongest copper-fastened vessel, and in a short time sink her. One man with such a machine can successfully contend against whole fleets at anchor.

REPORT OF THE ENGINEER IN CHIEF OF THE GEORGIA RAILROAD AND BANKING COMPANY, TO THE STOCKHOLDERS, *May* 10, 1840.

(Continued from page 336.)

At this stage of our operations, it is proper that I should present to the board a consolidated statement, of the various estimates heretofore submitted by me, and upon which they have authorized their expenditures.

Estimated cost of the Union road including depots and machinery, submitted May, 1836,	$1,051,209 00
Estimate of Madison branch, May, 1838,	607,874 00
" Athens " " "	398,936 00
" Machinery, etc. for both branches,	160,000 00
" Warrenton branch,	32,000 00
Total,	$2,250,019 00

This sum is inclusive of real estate, right of way, and interest on advances by the bank to the road, amounting to $172,654, items for which I could not then venture even an approximate estimate. To these might also be added no inconsiderable sum paid for exchanges in consequence of the depreciation of the currency since the first suspension of the banks. The estimates for the first and largest item in the above statement were made before the great rise in the price of nearly every element which enters into the cost of Railroads; yet notwithstanding this and other disadvantageous circumstances, the actual cost of the whole work, embracing a distance of 147 miles—a large portion of the route passing over ground of unusual difficulty, will not be found to differ $25,000 from the estimates.

The business of the Road during the year ending on the 31st of March, has not been as flattering as the previous years, owing chiefly to the failure of the cotton crop, which probably occured to a greater extent in the counties tributary to our Road than in any other portions of the South.

A decrease in the travel, a necessary consequence of a short crop, will also be observed by the returns. The same influence would likewise have extended itself to the up freight, had not the former prudence of the merchants of the interior suffered their stocks of goods to become unusually light, and in consequence, the Spring business up has been under all the circumstances, very fair. It is also satisfactory to observe from the destination of the merchandize passing over our Road, that the circle of our customers is continually extending and now embraces a large portion of the States of Alabama and Tennessee.

The following statement exhibits a general view of the receipts and disbursements for the year, on the Road in use, averaging 105 miles in length. It will be recollected in comparing it with last years statement, that the latter was for 11 months, and that although the Road was extended on one Branch 14 miles and on the other 6 to 12 miles, the charges for the up freight remained the same, and on cotton it was reduced from $1 50, the price charged from Greensboro, to $1 25 per bale from Buck Head. For more detailed statements of the buisness and expenses of the Road, I refer you to the accompanying documents marked Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12.

Business of the Georgia Railroad for 12 *months ending March* 31*st*, 1841.

Receipts for Freight Up,	$37,463 61	
" " " Down,	28,963 71	
" " Passengers Up,	33,329 02	
" " " Down,	32,933 02	
" " Mails,	22,373 52	
" " Miscellaneous,	3,162 23	
Total,		158,225 11
Expenses of Conducting Transportation,	17,869 60	
" " Motive Power,	22,652 58	
" " Maintenance of Way,	21,836 61	
" " " " Cars,	4,924 25	
Total,		67,283 34
Leaving net profit,		$90,941 77

Equal to *six* per cent. on the cost of the road in use, notwithstanding the short crop and reduced rates.

In addition to the regular business above enumerated, there was conveyed on the road materials for the superstructure, etc. of both branches, as follows:

912,000 feet, B. M. of string pieces, cross ties, and mud sills, which, at $1 per M. per 10 miles, is	$6,384 00
65,000 feet, B. M. for bridges, at $5 per M.,	325 00
24,000 " " " Depots, at $6 " "	144 00
1,650 tons of Iron and spikes, at $9 " ton,	14,850 00
Total,	$21,703 00

During the preceding 11 months a large amount of similar transportation was done of which no account was taken, and I now only refer to it to exhibit the true amount of business compared with the expenses, which is the customary, though delusive method of ascertaining the economy of rail-road management. If we follow out this mode of comparison, it will be seen that our expenses are but 30 per cent of the income supposing the business to have been the same.

To accomplish the years business our trains have traversed a distance of 110,540 miles,—dividing the expenses ($67,283 34) by this, will give the average cost of working the road per mile run 60 8-10 cents. The expenses for the last *eleven months* were over 63 4-10 cents per mile.

The item for maintenance of way, it will be recollected embraces the damages sustained by the finished road from the freshets of May 1840 and March 1841, so far as the latter has advaced on the first instant. The injury sustained from the May freshet by the road in use, was principal confined to that part overflowed by the Savannah river, and from the March freshet, to two breaks in the embankments 16 miles from Augusta, and several slips in the cuts along the line, of more or less extent, only one of which, in a cut 30 feet in depth, adjoining the Oconee, was of sufficient extent to interrupt the travel. At both periods the transportation of freight was stopped for about a week, but from the fortunate position of our trains at the time the travel was not materially interrupted.

In conducting the business of the company, I have the pleasure to state that I have received from all the Officers and Agents in the several departments under my control cordial co-operation in the discharge of the various duties devolving on them, and whenever extraordinary services were required, they have been cheerfully rendered. The duties of Superintendant of Transportation and Assistant General Agent, are still performed by Richard Peters, Jr., with unabated ardor and devotion to the interest of the Company.

I would recommend a renewal of the application to the Legislature for the privilege of increasing our rates for passage to at least 6¼ cents per mile.

If the Railroad Companies North of us, and the Stage proprietors South, could be induced to reduce their rates to our scale, the additional travel which would thereby be diverted from the Mississippi to this route would no doubt fully compensate all for the decrease of rates, but as that object has hitherto been opposed by these companies in a manner which leaves but little expectation of its being soon carried out, I can see no sufficient reason why we who have to incur the additional expense and risk of a night line in both directions, should be compelled to receive at least 20 per cent less than other companies, especially when it is recollected that the additional charges would fall chiefly upon non-residents of the State.

Respectfully submitted by

Your obedient servant,

J. Edgar Thomson,

Chief Engineer and General Agent.

Names of Engines.	Makers' Names and Class.		Commencement of service.	Number of miles run by each engine, from 1st of April, 1840, to 1st of April, 1841.		Cost of extraordinary repairs of cnch engine, from 1st April, 1840, to 1st of April, 1841.	Cost of extraordinary repairs to each engine, from 1st April, 1840, to 1st of April, 1841.	Total cost of repairs to each engine from 1st of April, 1840, to 1st of April, 1841.	Cost of ordinary repairs to esch engine, from commencement of service, to 1st of April, 1841.	Total number of miles run by each engine, from commencement of service, to 1st of April, 1841.	Cost of extraordinary repairs to each engine, from commencement of service, to the 1st of April, 1841.	Total cost of repairs to each engine, from commencement of service to 1st of April, 1841.	REMARKS.
Georgia,	Baldwin, Vail and Hufty.	No. 3	May 5, '37.		a	968 06		968 06	2,073 58	29,380	96 00	2,169 58	Shop, undergoing repair.
Pennsylvania,		" 3	" " "	4,750	b	360 73		360 73	2,034 26	39,735		2,034 26	Road, good order.
Florida,		" 3	Dec 27, "	18,195	c	528 32	10 87	539 19	1,856 19	39,636	108 30	1,964 49	Honse, good order.
Alabama,		" 3	Jan 12, '38.	18,040	d	606 30	161 00	767 30	1,670 48	50,807	434 42	2,104 90	Shop, undergoing repair.
Louisiana,		" 3	Feb 2, "	18,005	e	1,074 22	146 25	1,220 47	2,516 10	52,602	359 37	2,875 47	Road, good order.
Tennessee,		" 3	M'y 29, "	12,495	f	706 87		706 87	1,396 48	39,289	193 98	1,590 46	House, complete order.
Wm. Dearing,		" 2	Nov 6, "	11,660	g	344 06		344 06	891 81	35,168	168 10	1,059 91	Road, good order.
Virginia,		" 2	Dec 24, "	9,930	h	801 11	55 00	856 11	1,402 95	31,470	316 19	1,719 14	House, complete order,
Mississippi,		" 2	" 28, "	3,800	i	271 50		271 50	565 46	15,137	473 56	1,039 02	House, good order.
Kentucky,		" 2	Mar 24, '39.	8,015	j	417 79		417 79	873 61	23,975	55 86	929 47	House, good order.
Wm. Cumming,		" 2	Dec 14, "	2,200	k	113 75		113 75	113 75	3,815	19 83	133 58	House, complete order.
James Camak,		" 2	" 23, "	3,450	l	226 36		226 36	226 36	5,475		226 36	Road, good order.
				110,540		6,419 07	373 12	6,792 19	15,621 03	366,489	2,225 61	17,846 64	

Extraordinary Repairs—Embraces the cost of repairing engines, damaged by accident.

Principal items of ordinary repairs, comprising the amounts stated in the fifth column.

a. A new set of copper flues, new iron frame and truck, cast iron braces to engine, etc.
b. New cast iron braces, $150, left out in original plan of engine, etc.
c. New Truck frame, new Tender frame, etc.
d. New set of springs, $45. New Truck frame and new wheels, $200.
e. New Truck, wheels and axles complete, $500; new crank axle, $200; new set of springs, $46 50
f. New Truck wheels and axles complete, $500. Boring cylinders, straightening crank axle, etc., etc.
g. New pair of wheels and axles for Tender, boring cylinders, etc.
h. New pair of driving wheels and axle complete, $701, etc.
i. New crank axle, $200, etc.—*j.* New Tender wheels, etc., etc.
k. & *l.* New work omitted or partially executed by the makers of the engine.

Condensed statement of the aggregate amount of business done on the Georgia Railroad, from April 1*st*, 1840 *to April* 1*st*, 1841.

	No. Passengers.	Amount.	Freight.	Mail.	Total.
April,	1,885½	$5,689 18	$7,098 55	$1,713 56	$14,501 29
May,	1,781½	5,101 75	5,084 81	1,713 56	11,900 12
June,	1,752½	5,033 40	2,391 58	1,713 56	9,138 54
July,	1,832	4,640 99	2,144 97	1,713 56	8,499 52
August,	1,816	4,514 88	2,327 71	1,713 56	8,556 15
September,	1,650	4,340 50	3,398 44	1,713 56	9,452 50
October,	2,165½	6,494 31	5,940 90	2,015 36	14,450 57
November,	1,844½	5,742 87	5,559 36	2,015 36	13,317 59
December,	2,396½	7,031 09	8,179 03	2,015 36	17,225 48
January,	1,981	5,751 08	6,901 28	2,015 36	14,667 72
February,	1,934½	5,895 18	7,848 57	2,015 36	15,759 11
March,	1,921	6.026 81	9.552 12	2.015 36	17.594 20
Total,	22,910½	66,262 04	66,427 32	22,373 52	155,062 88
Way passengers, Warrenton Branch,					48 75
Way passengers, Athens Branch,					83 36
Passengers by freight trains,					108 17
Extra trips,					383 56
Extra baggage and specie,					232 49
Freight between stations,					93 91
Premium on post office warrants,					1,275 57
Interest on freight notes,					936 42
					$158,225 11

Statement of expenses incurred for working the Georgia railroad, from April 1*st*, 1840, *to April* 1*st*, 1841.

TRANSPORTATION DEPARTMENT.		
Stationery, Printing, etc.,	475 04	
Loss and damage,	738 67	
Incidentals,	883 45	
Oil and tallow for cars,	182 78	
Provisions, clothing, doctors bills, and other expenses of negroes,	2,593 98	
Expense of mules and pay of conductors Warrenton Branch,	799 43	
Wages of laborers,	2,355 11	
Agents and clerks,	7,356 39	
Conductors,	2,484 75	17,869 60
MAINTENANCE OF CARS.		
Repairs, etc.,	4,735 20	
Car factory, lumber swept away and spoiled by freshet in 1840,	189 15	4,924 35
MOTIVE POWER.		
Stationery, printing, etc.,	16 25	
Expense of water stations,	2,480 98	
Incidentals,	27 95	
Fuel,	5,402 87	
Oil, packing, etc., for engines,	1,177 54	
Ordinary and extraordinary repairs of engines,	6,792 19	
Engine and firemen,	4,715 13	
Provisions, clothing, doctors bills and other expenses of negroes,	2,039 97	22,652 88

MAINTENANCE OF WAY.

Mens wages,	12,103 67	
Provisions, clothing, doctors bill and other expenses of negroes,	1,592 35	
Incidentals,	180 49	
Tools,	377 56	
Wooden rails, cross-ties, etc.,	5,446 38	
Supervisors,	1,699 96	
Work done and materials furnished by car factory for repairs of road chiefly in consequence of freshets in May, 1840, and March, 1841,	436 20	21,836 61
		$67,283 44

MEMOIRS OF SCIENTIFIC MEN.—THE TWO FOLLOWING MEMOIRS ARE FROM THE ADDRESS OF THE PRESIDENT DELIVERED AT THE LAST ANNIVERSARY MEETING OF THE ROYAL SOCIETY.—Simon Denis Poisson, one of the most illustrious men of science that Europe has produced, was born at Pithviers on the 21st of June, 1781, of very humble parentage, and was placed, at the age of fourteen, under the care of his uncle, M. L'Enfant, surgeon, at Fontainbleau, with a view to the study of his profession. It was at the central school of this place that he was introduced to the notice of M: Billy, a mathematician of some eminence, who speedily discovered and fostered his extraordinary capacity for mathematical studies. In 1793 he was elected a pupil of the Ecole Polytechnique, which was then at the summit of its reputation, counting among its professors, Laplace, Lagrange, Fourier, Monge, Prony, Berthollet, Fourcroy, Vanquelin, Guyton Morveau, and Chaptal. The progress which he made at this celebrated school surpassed the most sanguine expectations of his kind patron, M. Billy, and secured him the steady friendship and support of the most distinguished of his teachers. In the year 1800, he presented to the Institute a memoir, "Sur le nombro d'integrales completes dont les equations aux differences finies sont susceptibles," which cleared up a very difficult and obscure point of analysis. It was printed, on the recommendation of Laplace and Lagrange, in the *Memoires des Savans Etrangers*, an unexampled honor to be conferred on so young a man. Stimulated by its first success, we find him presenting a succession of memoirs to the Institute on the most important points of analysis, and rapidly assuming the rank of one of the first geometers of his age. He was successively made Repetiteur and then Professor of the Polytechnic School, Professor at the College de France and the Faculte des Sciences, member of the Bureau des Longitudes, and finally, in 1812, member of the Institute. His celebrated memoir on the *invariability* of the major axes of the planetary orbits, which received the emphatic approbation of Laplace, and secured him throughout his life, the zealous patronage of that great philosopher, was presented to the Institute in the year 1808. Laplace had shown that the periodicity of the changes of the other elements, such as the eccentricity and inclination, depends on the peirodicy of the changes of the major axis —a condition, therefore, which constitutes the true basis of the proof of the stability and permanence of the system of the universe. Lagrange had considered this great problem in the Berlin Memoirs for 1776, and had shown that, by neglecting certain quantities which might possibly modify the result, the expression for the major axis involved periodical inequalities only, and that they were consequently incapable of indefinite increase or diminution. It was reserved to Poisson to demonatrate *a priori* that the non-periodic terms of the order which he considered would mutually destroy each other—a most important conclusion, which removed the principal objection that existed to the validity of the demonstration of Lagrange. This brilliant success of Poisson in one of the most difficult problems of physical astronomy, would appear to have influenced him devoting himself thenceforward almost exclusively to the application of mathematics to physical science; and the vast number of memoirs and works (amounting to more than 300 in number,) which he published during the last thirty years of his life, made this department of mathematical science, and more particularly whatever related to the action of molecular forces, pre-eminently his own. They comprehend the theory of waves and of the vibrations of elastic substrnces, the laws of the distribution of electricity and magnetism, the propogation of heat, the theory of capillary attraction, the attraction of spheroids, the local magnetic attraction of *ships*, important problems on chance and a multitude of other subbjects. His well known treatise on mechanics is incomparably superior to every similar publication in the clear and decided exposition of principles and methods, and in the happy, luminous combination of the most general theories with their particular and most instructive applications. Poisson was not a philosopher who courted the credit of propounding original views which did not arise naturally out of the immediate subjects of his researches; and he was more disposed to extend and perfect the application of known methods of analysis to important physical problems, than to indulge in speculation on the invention or transformation of formulæ, which, however new and elegant, appeared to give him no obvious increase of mathematical power in the prosecution of his inquiries. His delight was to grapple with difficulties which had embarrassed the greatest of his predecessors, and to bring to bear upon those vast resources of analysis and those clear views of mechanical and physical principles in their most refined and difficult applications, which have secured him the most brilliant triumphs in nearly every department of physical science. The confidence which he was accustomed to feel in the results of his analysis—the natural result of his own clear perception of the necessary dependence of the several steps by which they were deduced—led him sometimes to accept conclusions of a somewhat startling character; such were his views of the constitution and finite extent of the earth's atmosphere, which some distinguished philosophers have ventured to defend. It is not in mathematical reasonings only that we are sometimes disposed to forget that the conclusions which we make general are not dependent upon our assumed premises alone, but are modified by concurrent or collateral causes, which neither our analysis nor our reasonings are competent to comprehend. The habits of life of this great mathematician were of the most simple and laborious kind; though he never missed a meeting of the Institute, or a lecture, or an examination, or any other public engagement, yet on all other occasions, at least in later years, he denied access to all visitors, and remained in his study from an early hour in the morning until six o'clock at night, when he joined his family at dinner, and spent the evening in social converse, or in amusements of the lightest and least absorbing character, carefully avoiding every topic which might recall the severity of his morning occupations. The wera and tear, however, of a life devoted to such constant study, and the total neglect of exercise and healthy recreations, finally undermined his naturally vigorous constitution, and in the autumn of 1838 the alarming discovery was made that he was laboring under the fatal disease of water in the chest. The efforts of his physician contributed for a long time to mitigate the more serious symptoms of his malady; but every relaxation of his sufferings led to the resumption of his labors; and to the earnest remonstrances of his friends, and the entreaties of his family, he was accustomed to reply, that to him *la vie c'etait le travail;* nay, he even undertook to conduct the usual examinations of the Ecole Polytechnique, which occupied him for nearly ten hours a day for the greatest part of a month. This last imprudent effort ended in an attack of paralysis, attended by loss of memory and the rapid obscuration of all his faculties; he continued to struggle, amidst alternations of hope and despondency, for a considerable period, and died on the 25th of April last, in the 59th year of his age. Poisson was eminently a deductive philosopher, and one of the most illustrious of his class; his profound knowledge of the labors of his predecessors, his perfect command of analysis, and his extraordinary sagacity and tact in applying it, his clearness and precision in the enunciation of his problems, and the general eleganae of form which pervaded his investigations, must long continue to give to his works that classical character, which has hitherto been almost exclusively appropriated to the productions of Lagrange, Laplaee, and Euler. If he was inferior to Fourier or to Fresnel in the largeness and pregnancy of his philosophical views, he was incomparably superior to them in mathematical power; if some of his contemporaries rivalled or surpassed him in particular departments of his own favorite studies, he has left no one to equal him, either in France or in Europe at large, in the extent, variety, and intrinsic value of his labors. The last work on which he was engaged was a treatise on the theory of light, with particular reference to the recent researches of Cauchy; nearly two hundred prges of this work are printed, which are altogether confined to generalities, whose applications were destined to form the subject of a second and concluding section: those who are acquainted with the other works of Poisson will be best able to appreciate the irreparable loss which optical science has sustained in the non-completion of such a work from the hands of such a master.

Richardson's Accelerated Steamboat.—We have before us a drawing and description of a new kind of steamboat, invented by Col. J. S. Richardson. Its leading peculiarity is that by means of a huge balloon, or gas, holder, shaped like a cucumber, and extended lengthwise over the boat (or rather boats, for there are two hulls connected by a deck and saloon above,) the latter is raised out of the water, except the keels and paddles or the water wheels, thus reducing the resistance of the water to almost nothing and yet using it for the purposes of propulsion and steering. The plan is ingenious, but how it will succeed in practice, we shall know better when the experiment is made. Col. Richardson and his associates have announced their intention to build and put in operation, one of these boats on the north river. The balloon is to be made of duck and divided into sections so that in being perforated by a vessel's boom, or other cause, only a small part of the gas would escape. Supposing the plan to operate in practice as it presents itself in theory, a rate of speed, would be attained that would distance all other, traveling expedients. It is easy enough to see, that with steam power applied to the water as in other steamboats, and with little resistance from the water, the boat must go ahead with astonishing rapidity.—*Jour. Com.*

Discovery of Tin Ore.—Extract of a letter, dated Walpole, N. H., 15 June:—Dr. Jackson, the State geologist, states the certain existence of tin ore on the eastern slope of the White Mountains, in the town of Jackson, county of Coos, N. H. Dr. Jackson appears to be of the opinion that the ore will prove to be abundant—if so, this is the first discovery of tin in quantity in the United States.